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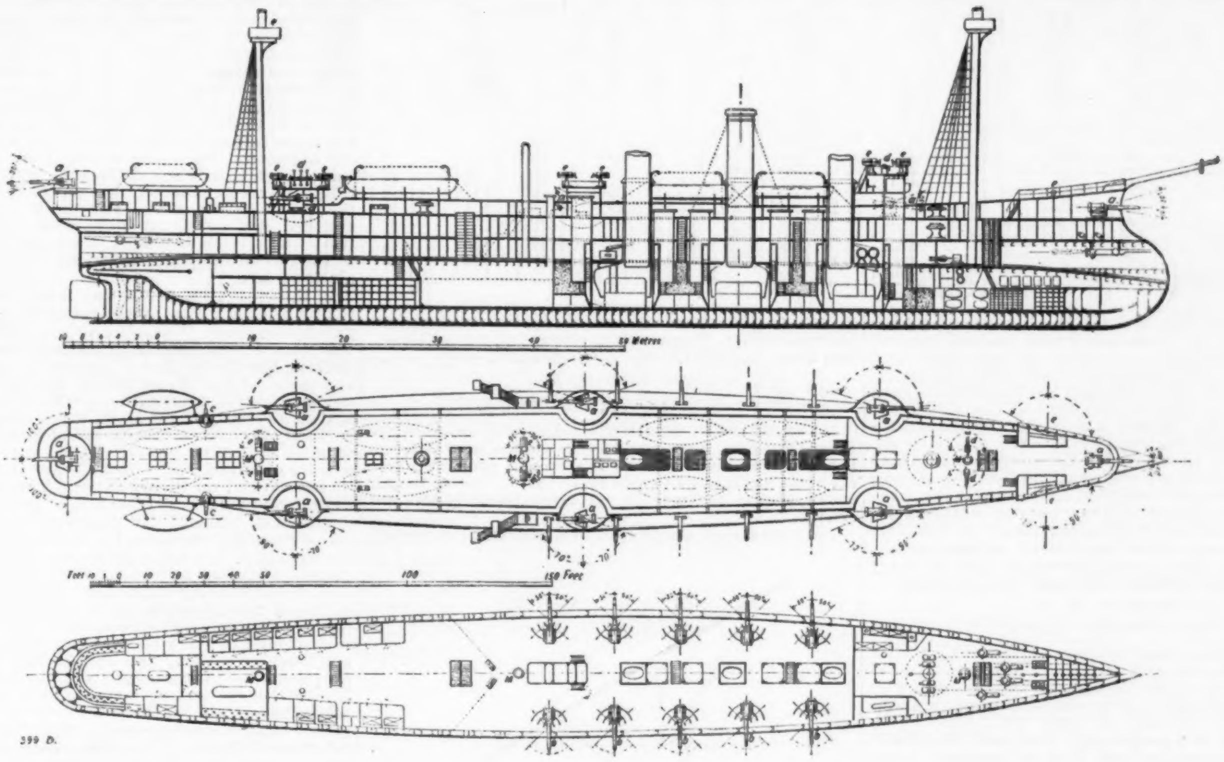
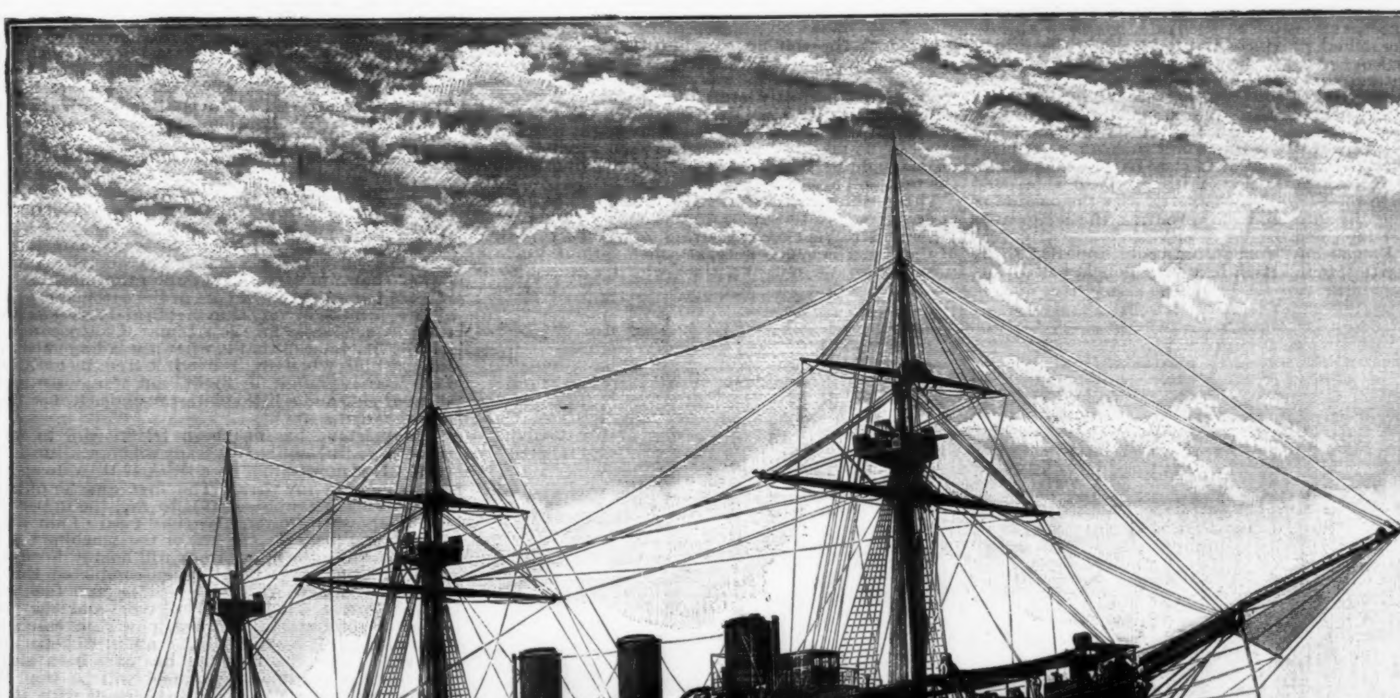




THE FRENCH WAR SHIP CECILLE.

THE FRENCH WAR SHIP CECILLE.

THE Cecille, named after a French admiral, distinguished by his services in Chinese waters, was constructed by the Forges et Chantiers de la Mediterranee, at their La Seyne works, from the designs of the company's chief engineer, M. Lagane. The Cecille is a cruiser with inclosed batteries, with an armored deck; the principal side protection are caissons on each side packed with cellulose, while the engine space is still further protected by armor plates; the ship is, however, classed as a non-armored cruiser. There are in all nine vessels of this class in the French navy, differing widely from each other as regards size, construction, speed, and armament; the following table gives particulars of the series:

PARTICULARS OF FRENCH FIRST CLASS CRUISERS.

Name.	Date of launching.	Materials used in construction.	Length.		Beam.		Draught.		Displacement.	Engines.	Speeds.	Screws.	Coal storage.	Torpedo tubes.	Crew.	Armament.			
																16 cent. (6·29 inch.)	14 cent. (5·51 inch.)	Quick firing guns.	Machine guns.
			ft.	in.	ft.	in.	ft.	in.	tons.	h. p.	knots	No.	tons.	No.	No.				
Arethuse	1882	Wood	275	7	42	8	22	6	3,649	4,174	15·5	1	400	..	474	4	22	..	8
Cecille	1888	Iron and steel	377	3	49	2	22	3	5,366	9,600	19·0	2	....	4	486	6	10	5	10
Dubordieu	1884	Wood	252	7	45	11	22	9	3,566	3,179	13·9	1	....	2	496	4	12	..	10
Duquesnes	1876	Iron	331	4	49	2	27	8	5,824	8,375	16·8	1	800	..	550	7	14	..	8
Iphigenie	1881	Wood	239	6	45	11	21	11	3,285	3,107	13·3	1	400	..	391	6	2	..	10
Naiade	1881	Wood and Iron	246	0	45	11	23	6	3,525	2,700	13·6	1	400	..	496	2	18	..	10
Sfax	1884	Steel	288	8	49	2	25	0	4,502	6,522	16·7	2	....	5	473	6	10	..	10
Tage	1884	"	390	6	52	6	24	6	7,045	12,410	19·0	2	900	7	400	6	10	5	10
Tourville	1876	Iron	331	4	49	2	25	10	5,743	7,467	16·9	1	800	..	550	7	14	.	8

The engine power of 9,600 is obtained only with forced draught, the horse power with natural draught being 6,900. The power comprises two main compound vertical engines each actuating a screw shaft, eight auxiliary engines for air, circulating, feed pumps, etc., and eight engines for driving the fans of the stokeholds and engine rooms. Steam is generated by three independent groups of boilers, two in each group, working at 85 lb. per square inch; there are besides three boilers for the auxiliary engines. The Cecille has three masts, and has a sail surface of 2,000 square feet; the lower masts are of steel, and serve as ventilating shafts for the space below the armored deck. A complete system of drainage tubes are placed throughout the ship, and are connected to a Thirion centrifugal pump able to discharge 1,000 tons an hour.—*Engineering.*

THE PRESIDENTE ERRAZURIS.

WE have several times spoken of the situation in which Chile finds herself, owing to the co-existence of two governments—a *de facto* one at whose head presides Mr. Balmaceda, and one which assumes the name of congressional government, and which, elected by the members of the parliament, leaders of the insurrection, has the appearance of a government based upon constitutional law.

The congressional government has, from the start, had the good fortune to have control of the best part of the fleet, and, owing to such aid, has been able to hold the richest provinces and to blockade the principal ports of Chile.

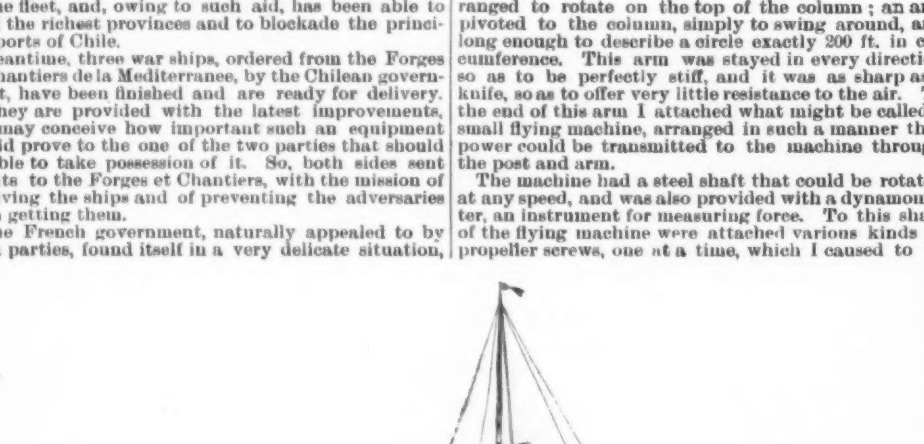
Meantime, three war ships, ordered from the Forges et Chantiers de la Mediterranee, by the Chilean government, have been finished and are ready for delivery. As they are provided with the latest improvements, one may conceive how important such an equipment would prove to the one of the two parties that should be able to take possession of it. So, both sides sent agents to the Forges et Chantiers, with the mission of receiving the ships and of preventing the adversaries from getting them.

The French government, naturally appealed to by both parties, found itself in a very delicate situation, having to decide between a *de facto* government and a government that seems to be the issue of a regular constitutional law.

The affair has taken a judicial turn in consequence of a demand of sequestration made by the agents of the insurrectionists. The sequestration having been accorded, an appeal from the sentence was made, and the first debates upon this were begun lately. The sequestration was not upheld.

Without giving any opinion upon the merits of the case, we present herewith an engraving of one of the ships concerned—the Presidente Errazuris.

She is a cruiser 267 ft. in length, 36 in breadth, and of 2,000 tons burden, and to which a 5,400 h. p. engine should give a speed of 19 knots. She is armed with four Canet rapid-fire guns of 6 in. caliber, and two others of the same system of 4¾ in. caliber, four Hotchkiss guns, four revolving guns, two mitrailleuses, and three torpedo tubes.—*L'Illustration.*

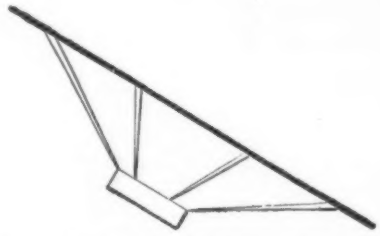


THE NEW CHILEAN WAR SHIP PRESIDENTE ERRAZURIS.

THE MAXIM FLYING MACHINE.

MY experiments, says Mr. Maxim, as reported in the *New York Sun*, have not been in the realm of ballooning, but on the aeroplane system—to propel a plane set at an angle so as to ride on the air as fast as the air yields, and so to keep up an approximately straight course.

I put up a steel column, with a long wooden arm ar-



ranged to rotate on the top of the column; an arm pivoted to the column, simply to swing around, and long enough to describe a circle exactly 200 ft. in circumference. This arm was stayed in every direction so as to be perfectly stiff, and it was as sharp as a knife, so as to offer very little resistance to the air. To the end of this arm I attached what might be called a small flying machine, arranged in such a manner that power could be transmitted to the machine through the post and arm.

The machine had a steel shaft that could be rotated at any speed, and was also provided with a dynamometer, an instrument for measuring force. To this shaft of the flying machine were attached various kinds of propeller screws, one at a time, which I caused to be rotated at various speeds. The apparatus when complete was arranged to correctly indicate the number of turns per minute, the actual push or propelling force of the screw, and the slip of the screw. When the arm was allowed to go free and the screw was rotated at a high speed, the flying machine would travel around the circle at from thirty to ninety miles an hour.

The machine was also provided with a system of levers similar to those used in ordinary druggists' scales, and to this were attached planes, generally made of wood, and arranged in such a manner that they could be placed at any angle above the horizontal. By carefully measuring the power required for a certain speed without any plane attached, and then attaching the plane and running the machine at exactly the same speed, the difference in the force required for both operations indicated the actual force required to propel the plane.

The apparatus for holding the plane was provided with a carefully made dynamometer, which measured and registered the lift of the plane—the amount it would lift when being driven through the air. When these planes were perfectly horizontal and the machine was allowed to travel at a high velocity, nothing was registered, but if the front or advancing edge of the plane was raised slightly above the horizontal—say 1 in 30—then it was found to have a tendency to rise. On one occasion, when a plane was placed at an angle of 1 in 25, it was found that it would carry 250 lb. to the horse power, but this result was only obtained on one occasion. The angle was so slight and the speed was so high that it was difficult to arrive at the same result the second time on account of the trembling of the plane in the air. The angle was accordingly changed, and nearly all subsequent experiments were tried with the plane placed at an angle of 1 in 14—that is, that when the plane advanced 14 ft. it pressed the air down 1 ft.

In these experiments it was found that with every pound of push given by the screw 14 lb. could be carried by the plane. The skin friction on the screw and on the plane was so small as to be unappreciable. It was nothing like the friction of a screw in the water. With the angle of 1 in 14 everything ran smoothly, and experiments were tried with all speeds between 20 miles and 90 miles an hour. These experiments proved that certainly as much as 133 lb. could be carried with the expense of 1 horse power. These are the data I personally obtained, and which I know to be true. They do not depend on theory at all. The small planes experimented with were from 2 ft. to 13 ft. long and from 6 in. to 4 ft. wide. Fifty different forms of screws or screw propellers were used in conducting these experiments...... My large apparatus is provided with a plane 110 ft. long and 40 ft. wide, made of a frame of steel tubes covered with silk. Other smaller planes attached to this make up a surface of 5,500 square feet. There is one great central plane, and to this are hinged various other planes, very much smaller, which are used for keeping the equilibrium correct and for keeping the flying machine at a fixed angle in the air. The whole apparatus, including the steering gear, is 145 ft. long. The machine is provided with two compound engines, each weighing 300 lb. The steam generator weighs 350 lb. The other things, the casing about the generator, the pump, the steam pipes, the burner, the propellers, and the shafting, all weigh 1,800 lb. Everything is remarkably light, so remarkably light that one grate bar in a boiler that generates as much steam as mine would weigh more than my whole boiler. It is made of copper and steel brazed with silver solder. There are 48,000 brazed joints in the generator, and it is heated by 45,000 gas jets, there being 40 ft. of grate surface. The heat thus produced is perfectly terrific. The boiler was tested up to 900 lb. pressure, and it didn't leak a drop.

The most novel feature about the engine is the system by which I burn petroleum and generate steam. Petroleum is turned into gas, and then that is burned for generating steam. The engines have lately been tried, and it was found that they gave a push of 1,000 lb. on the machine, which seems to indicate that the machine will carry 14,000 lb. The actual amount of power shown in useful effect upon the machine itself was 120 horse power. A part of the aeroplane, or actual kite, is made of very thin metal, and serves as a very efficient condenser for the steam. It looks much like a kite; . . . indeed, that is what it is, a huge kite, with the machinery hanging beneath it from its under side. If it were in the air, in flight, you would see a great sheet of silk and a little platform under it, between it and the earth.

The machine has not been tried, owing to my absence from England. It is ready and awaiting my return. It is now resting on a track 12 ft. wide and half a mile long, in my park. The first quarter of a mile of the track is double—that is to say, the upper track is 3 in. above the lower. By that means I am able to observe and measure the lift of the machine when it starts, because the upper track will hold it down when it lifts off the lower one. When completed the machine will weigh, with water tanks and fuel, somewhere between 5,000 lb. and 6,000 lb., and the power at my disposal will be 300 horse power in case I wish to use it; but it is expected that about 40 horse power will suffice after the machine has once been started, and that the consumption of fuel will be from 40 lb. to 50 lb. per hour. The machine is made with its present great length so as to give a man time to think; its length makes it easier to steer, and to change its angle in the air. Its quantity of power is so enormously great in proportion to its weight that it will quickly get its speed. It will rise in the air like a seagull if the engine be run at full speed while the machine is held fast to the track and if it is then suddenly-loosened and let go. If it were necessary it could mount right up, spirally, around and around in a circle of a mile in circumference in its own country.

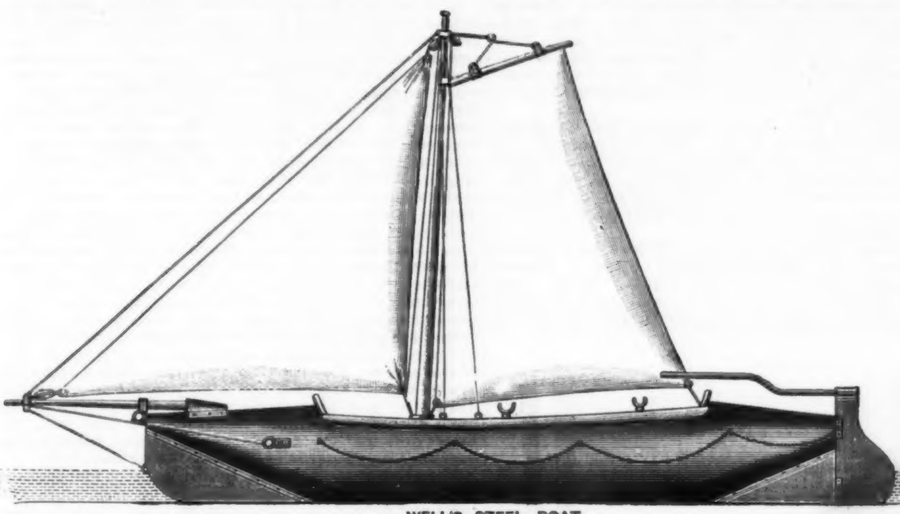
If it proves as I have figured it there should be room for fuel to carry it 1,000 miles. Indeed, it looks as if it might carry two tons of fuel, or sufficient to propel it across the ocean. But I cannot tell about that. A trial alone will determine what unforeseen things, not calculated, will arise. It will be possible to burn 200 lb. of fuel an hour, but I figure that 40 lb. or 50 lb. will produce a moderate speed, or for high speed, 100 lb. The highest speed I got on the small machine was 90 miles an hour, but I believe this big one will go 100 miles an hour.

If it goes at all, I shall be very happy, but on the

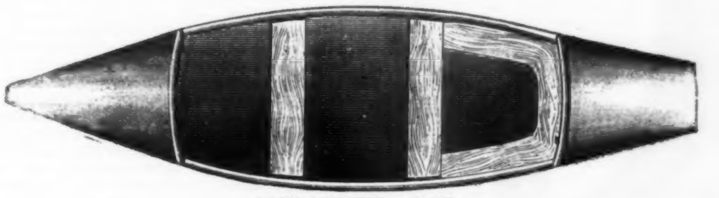
basis of my figuring it ought to be able to develop between 250 and 300 horse power, and it ought to carry 9,000 lb., or 14,000 lb. with its own weight included. In warfare it would not need to carry so very much. Two men will be enough—two men and a little dynamite—a ton or a couple of tons.

As to wind, the winds are as apt to be favorable as unfavorable, but at a certain distance from the earth they cease to be formidable. You are always in a dead calm at a certain distance on high. Gales are narrow things; they don't disturb much space. Moreover, their strength and speed have been very much exaggerated in the popular mind. Let us suppose we are encountering a wind at forty miles an hour—a very unusual speed—then if the machine is regulated to go sixty miles an hour, it will travel twenty miles against the wind, or one hundred miles with it. . . .

As to what it will do, the whole world becomes changed if it works—the whole world will be revolutionized in a year. There will be no more ironclads, no more armor plates, no more big guns, no more fortifications, no more armies. There will be no way of guarding against what this machine will do.



WELL'S STEEL BOAT



PLAN OF STEEL BOAT

WELL'S STEEL LIFE BOATS.

THESE boats are built of steel, on a novel principle, and possess the invaluable qualities of being unsinkable and self-righting. The fore and aft sections of the boat are constructed in the form of hollow cones, slightly flattened and laid horizontally. These sections are thoroughly air and water tight, and their peculiar form imparts immense strength and rigidity to the whole structure. On an emergency, the patent steel boat could be thrown overboard bodily without the formality and care attendant on the use of boat-lowering gear, as no matter how the boat landed in the water it would float on an even keel, and could not possibly swamp.

These boats have been subjected to severe tests in the Firth of Forth, in all weathers, and have been demonstrated to possess all the qualities that are claimed for them. They are surprisingly fast under sail or oar, and answer to the rudder with unusual readiness, due to the special form of the keel. Only in the almost inconceivable possibility of the whole three sections being pierced, both above and below the water line, would the boat lose its buoyancy. The steel boats can be produced at a cost that will compare favorably with the price of good class wooden boats. They will stand usage that would quickly destroy wooden boats, but at the same time they are remarkably light, a boat 12 ft. long and 3 ft. beam, complete with mast, sails, oars, etc., approximating only 3 cwt.—*The Engineer.*

ADOPTION OF THE CANET RAPID-FIRE GUNS BY RUSSIA.

THE imperial Russian government, wishing to make a selection of a system of rapid-fire guns for the armament of its fleet, resolved to make some comparative experiments upon the different existing systems. In December, 1890, it wrote to several establishments to ask them if they would be willing to submit their systems to experiments and to open their doors to a Russian commission. This commission was composed of Captain De Brynk, president, Colonel Sanotzky, Captain Riazanine and Commandant Gros. It took trips several times to Germany, France and England. In the latter country notably the Armstrong Company made two series of experiments with 12 and 15 centimeter guns.

Les Forges et Chantiers made three series of experiments with the 12 and 15 centimeter guns of the same type as those with which the new Chilean ships Capitan Prat, Presidente Pinto and Presidente Errazuris are armed.

The Russian officers afterward witnessed some experiments at the Krupp and Grüson establishments in Germany.

The commission was led from the start to exclude the use of the wedge for rapid-fire guns of large caliber, and to adopt, in principle, the screw fastening. It found the wedge much too cumbersome for a *materiel* in which facility of maneuvering must be the main qualification. The firing was done with the greatest care, and consisted of ballistic firing properly so called, with a study of initial velocities and pressures, and rapid firing, in order to ascertain the number of shots that it was possible to fire in a given time. The experiments on velocity, made at Havre, with the Canet gun, led to the conclusion that it was possible to fire twelve shots per minute with the 12 centimeter gun and about eight with the 15 centimeter one. One of the characteristic features of the guns of this system is their power. The initial velocity given the projectile is very high, and, with smokeless powder, has reached 880 meters in a 15 centimeter gun and with a 40 kilogramme projectile.

There results from this both great accuracy and power, for the projectile with this velocity pierces a plate of forged iron 60 centimeters in thickness. Besides, the gun has resisted pressures of nearly 4,000 atmospheres.

The carriages are provided with a hydraulic brake and spring recuperator. A single winch serves for doing the upward and direct sighting.

After the firing performed in each of the different establishments, the officers devoted themselves to a minute examination of all the parts, and had all the pieces taken apart.

On returning to Russia, the commission made a report which recommends the adoption of the Canet system for rapid-fire guns. Consequently, the Minister of the Navy informed the Société des Forges et Chantiers de la Mediterranée that the Canet rapid-fire guns had been adopted in Russia.

This decision, made by a great power after extremely careful experiments executed by very competent officers, and experiments, too, that lasted more than three months, prove a genuine superiority of the Canet over the Armstrong system, with which the English war ships are armed. Besides, it sanctions the use of the screw, since this system of fastening has just been adopted by a country in whose entire regiementary *materiel* the wedge fastening was employed. The experiments made at the Hoc proving grounds, moreover, were watched by several officers of the marine and artillery of the French navy. They were likewise watched in part by a Danish commission composed of General Linnemann, Colonel Madsen and Captain Raabye.

The United States have just ordered a 12 centimeter gun, with which the government intends to make some comparative experiments.

Finally, the Canet guns are being experimented with at this moment by the navy. A special commission composed of officers of the marine and artillery, and at whose head is Colonel De la Rocque, has been specially appointed to this effect by the minister.

The result of the experiments made at Hoc is a new success for French industry that we are glad to chronicle. It shows us that we have nothing to ask for from foreigners, and that France continues to keep ahead as regards the improvements introduced into war *materiel*, and this can only make us rejoice, and reassure us.—*Le Genie Civil.*

LONGITUDINAL BEARINGS FOR RAILWAY TRACK.

MR. THOMAS C. CLARKE, in a paper recently read before the American Society of Civil Engineers, says:

It is admitted by civil engineers and other railway experts that our American system of track, which has done so well in the past, owing to its strength, elasticity and economy of first cost and maintenance, is now in a bad way, and must be modified in some manner to meet the ever increasing weight of cars and engines. This has grown during the last 15 years from 5 tons on a locomotive driver to 9½ tons; and 3 tons per car wheel to 5½ tons; and the end is not yet. Our track is giving out at all points. Joints which did well under lighter loads, now sink and allow rail ends to be battered down. Steel rails are not hard enough. Their heads crush, or the material itself flows under the heavy wheel loads. A new danger has shown itself. The old form of spike can no longer hold the rails to the ties. The sinking at the joints makes the rails saw up and down, and loosens the spikes. Then the gauge spreads and the trains leave the track. This form of accident is becoming more alarmingly frequent every year.

The supply of timber for ties is becoming a serious question. Statistics show that from 60,000,000 to 70,000,000 wooden ties are yearly required in the United States. Chemical preparation of the timber is claimed to double the life of the tie, so far as decay is concerned, at an increase of only about one-third of the first cost. But a new trouble appears. The great weights on the rails, aided by the sawing motion above described, cut their bases into the ties, and destroy them sooner than they rot. Thus we have rails, fastenings and ties, all failing together.

The writer of the paper therefore concludes that, "considering all these matters, and personally examining a great many improved forms of track, the only radical cure of the difficulty is to return to the old form of continuous rail and continuous bearing, improved to avoid those defects which experience has shown, and made capable of being extended in dimen-

CANET RAPID-FIRE GUN, ADOPTED BY RUSSIA.

sions and modified in material to meet the ever increasing loads of the future.

"The defects of the continuous bearing system as formerly made are as follows: The early form of continuous rails was made of such soft iron that the bearing parts cut into each other and soon worked loose. This cannot occur with steel members of proper proportions. The rails rested on longitudinal timbers. These had to go down so deep that they cut off drainage between the rails. Also, it was difficult to unite them to the wooden cross ties necessary to preserve the gauge. The great number of joints caused decay. For all these reasons the continuous system, although giving a very smooth track while new, soon got out of order, and was replaced everywhere by the wooden cross tie system, which was less expensive to make and far less so to maintain.

"The requisites of a properly designed longitudinal system are as follows:

First—The first is that the longitudinal bearer under the rail shall be stiff enough to transmit the load to such a distance, on each side of the wheel, as will limit the pressure to not much over two tons per square foot of bearing surface, without requiring excessive width. Experience has shown that a greater pressure than two tons per square foot will sink ties too deep into the gravel or broken stone.

Second—The next thing is to attach the rails and bearers together by a form of fastening strong enough to resist all strains and shocks, and yet allow of freedom of the rail to expand and contract, independently of its bearer. It must also be held to its bearer so that creeping of the rail on the bearer may be prevented, and that without any notching or cutting of the rail that will impair its strength. The rails must break joint with the bearers. The fastenings must be so made that the rails can be quickly removed and replaced by new ones without disturbing the bearers. The fastenings must be able to hold for a time a broken rail, so that it will safely pass the trains, and no system but the longitudinal can do this.

Third—The bearers (and rails) should be united firmly together by light metallic gauge ties, placed near enough to properly preserve the accuracy of the gauge.

Fourth—The bearers and gauge ties should be of such shapes as can be easily tamped with gravel or broken stone; as will stay in place vertically, laterally and longitudinally, and will allow of drainage to pass between them.

Fifth—The system should be so planned that no difficulty of construction can occur at curves, either in alignment or elevation of outer rail. Also it should be so made as to easily join to the ordinary form of T rail at turnouts and switches.

Sixth—Besides the obvious advantages which such a construction gives, there are two others: The upper rail can be made of a harder and better worked steel, while the bearer can be made of a softer and tougher quality of metal. Probably basic steel would do for this."

The author believes that a first class track, made with metallic longitudinal bearers, need not exceed the cost of a first class track laid with metallic cross ties.

DOUBLE COUNTERSINKING MACHINE WITH AUTOMATIC MOTION.

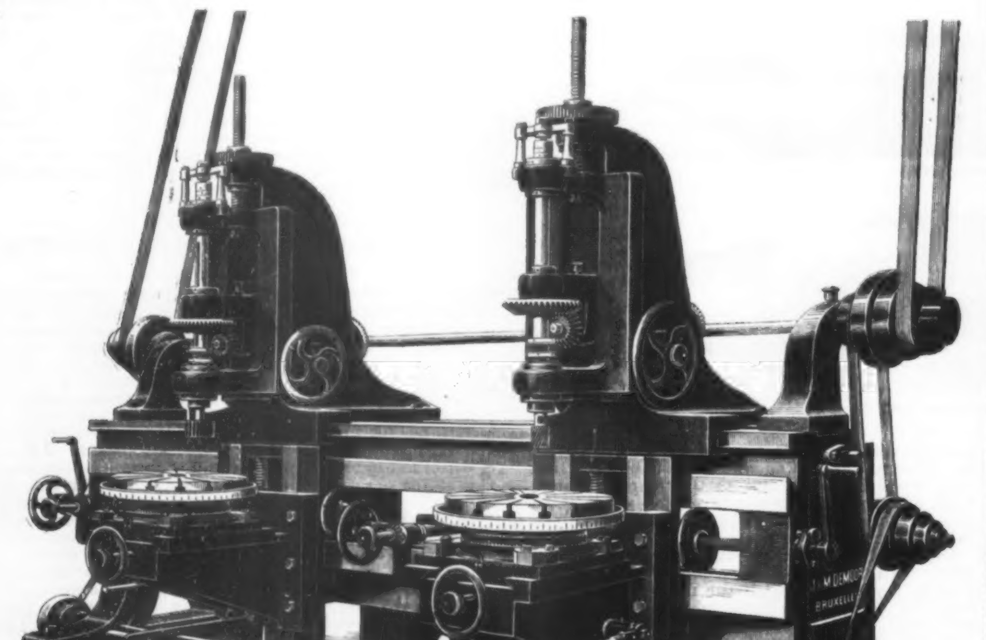
Long pieces that require at several points a finishing, such as the keying of a countershaft and of an axle, the boring and adjusting of bearings or of the heads of the same connecting rod, necessitate several shiftings, followed by as many regulations, when an ordinary countersinking machine is operated with. To reach the same result by means of a single operation is to abridge the duration of the work, to reduce the net cost, and, at the same time, to obtain guarantees of the greatest precision. Such are the desiderata realized by the Messrs. Demoor with the double countersinking machine shown in the accompanying engraving.

This tool consists essentialy of a rectangular bed 13 feet in length, supported by three legs having a wide surface at the base. Upon two perfectly true and polished surfaces, this bed receives two uprights for the countersink holders and two carriages for holding the objects to be countersunk.

The Uprights.—The uprights are moved parallel with each other on the bed by means of two distinct screws actuated at each extremity of the machine by winches. They are therefore independent. Their distance apart from axis to axis is 8¼ ft. at a maximum and 2 ft. at a minimum. In front of each of these uprights, there is a vertical carriage, which receives the toolholder shaft, and the 12 inch displacement of which is effected either automatically or by hand. This toolholder shaft revolves in three supports, viz.: Two sockets at the extremities of the carriage and an intermediate one. Its conical journals revolve in bearings of hard bronze, provided with regulating rings to compensate for wear.

Let us now see how the two uprights are actuated. Two shafts arranged in a line with one another, at the upper part of the machine, receive two 4-speed bevel wheels actuated by the shafting of the shop. From thence the motion is communicated to each of the tool-holder shafts through a double play of bevel pinions whose ratio is 1 to 2.

Upon these shafts there are likewise two 3-speed bevel wheels that act respectively upon a similar wheel placed to the left of the frame. These parts serve for effecting the vertical movements of the tool holder carriage, which are brought about in each of them by means of a horizontal shaft, of an endless screw, of bevel pinions, of a second horizontal shaft provided with a pair of bevel pinions, and finally by means of gear wheels arranged at the upper part of the uprights and actuating the vertical screw of the carriage.



DOUBLE COUNTERSINKING MACHINE.

It is thus possible to move these carriages vertically by hand through a hand wheel that may be seen to the right of the uprights.

Carriages.—As may be seen, the carriages, arranged upon the vertical face and in front of the bed, comprise, each of them, a vertical carriage, a bracket support, a horizontal carriage and a circular plate. As for the uprights, the mechanism of these two systems is absolutely independent of each other. Besides, all their motions can be effected by hand.

The actuating of these carriages is effected through the intermedium of 3-speed bevel wheels mounted at the extremities of the bed and actuating two lower shafts placed in a line with the machine. Upon each of these there is a reversing gear which moves with the brackets and actuates a vertical screw. The latter not only moves the vertical carriage and its bracket laterally, but also determines the automatic motions of the horizontal carriage (whose longitudial travel is 10 inches) and of the circular plate, which is 28 inches in diameter. The transverse motion of the vertical carriage with its bracket is effected through a horizontal screw at the center of the front of the bed. This screw is provided with a device that permits of changing from maneuvering by hand to an automatic operating. We shall not describe in detail the other automatic actuating mechanisms that are analogous to those employed in the carriages of an ordinary countersinking machine. They are thrown into and out of gear by means of friction bevel wheels, that can be instantly loosened or tightened.

As for the regulation of the height of the bracket support, that is done by hand through a pair of bevel pinions that actuate a vertical screw.

Upon the whole, this machine admits of six principal motions, four of which are automatic.

By Hand.—(1.) Lateral motion of the two uprights. (2.) Motion of the bracket support, *automatic* or by *hand*. (3.) Vertical motion of the carriage of the tool holder. (4.) Lateral motion of the carriage supporting the piece to be countersunk. (5.) Longitudinal motion of the horizontal carriage. (6.) Circular motion of the graduating plate. Owing to the independence of the two parts that constitute this machine, each of them may be used separately, so as to obtain from them altogether the work required from two strong vertical and automatic machines with circular plate.—*Revue Industrielle.*

ARCHITECTURAL ENGINEERING.

By J. Kendall Freitag, B.S.

Not far from the city of Cairo, in Egypt, stands the largest of the famous Egyptian pyramids—one of the grandest monuments that the architects of the past ages have left us in proof of the magnitude, solidity, and even harmonious splendor of their times. Its base, which is square, covers over 11 acres of the sands of the Nile, and its height little less than our Washington Monument, nearly 500 feet. The stones used in its construction would, perhaps, *each* serve as a monument at the present day, the smallest being 30 feet in length. Would not this, then, or if you will a more architectural structure, as the Temple of Babylon, 660 feet in height, and whose bricks were 20 feet long, 15 feet broad and 7 feet thick, form a fitting starting point for a long journey of friendship that has existed between the naturally allied arts of architecture and engineering—a mutual bond, both dealing with the structures of mankind, which has at last given us the present examples of strength and beauty that *Architectural Engineering* has made possible. *Architectural*, in reference to the form, expression, utility and beauty of the edifice; *Engineering*, perhaps hidden from the eye to a great extent if not wholly in the construction, durability and magnitude of the possibilities which open up before the mind accustomed to deal with the forces and matter of nature, and adapt them to the ever increasing needs of an exacting public.

For are not the temples, tombs, palaces and habitations of man the surest indications of the needs, customs and arts of the people who build them? Must not our resources keep pace with our wants, and provide for the constant progress and improvement that our complex lives require? Cain, the son of Adam, "builded a city, and called the name of the city after the name of his son, Enoch," the rude mud hut or the flimsy structure of reeds serving as a habitation; but by the gradual advancement of civilization, the materials of nature assume higher planes in the fulfillment of man's uses, till we gradually evolve the magnificent structures of modern architectural engineering.

The ethnologist tells us of an age of clay; then stone in the rough and later polished; an age of iron, then bronze, and of late we add the epoch of steel. Is it not so in our building construction? First the clay and the reeds, which even yet exist in China and eastern countries, and as we have so lately learned, so primitive even in our 19th century in dark Africa. Then the brick of clay and straw, the burned brick, and the age of stone reaching such a height of excellence as is shown us later by the works of the Grecians, Romans, and the palaces of the middle ages. Think of the Temple of Solomon at Jerusalem—46 years in erection, the historians tell us, and whose stones were 46 feet long, 21 feet high and 14 feet thick, some even of the great length of 82 feet. Would it not tax the ingenuity of an engineer to handle such masses of stone even in our own advanced age? But with the hurrying strides of civilization comes the demand for a cheaper and quicker construction, a medium to be more easily handled than the huge blocks of stone of early ages—a substance combining the strength, durability and adaptability required by our demands of commerce and rapid progress—a speedy return for our capital invested.

Such a material is found in steel—the symbol of our present age of construction and which has made possible the huge frameworks of metal and terra cotta that adorn our large cities to-day. And it is a few facts in connection with the engineering or constructional part of such a structure that I will try and present as being of value to the engineering student, though in only too many cases the architect who has designed the sugar-coated covering as it were, to make it palatable to the public, reaps all the reward and praise for what the engineer has made possible. And as the "sky scraper" office buildings of our American cities present interesting features, let us look at some of the problems involved in such construction.

Let us take as the subject of our consideration the twenty-storied structure known as the Masonic Temple, now building in the heart of the business portion of Chicago, the *home* we may safely say of the now too common sixteen, seventeen, twenty, and who can guess how many storied buildings. Our building occupies a prominent northeast corner at the intersection of two business thoroughfares, a lot of 170 feet front and 113 feet deep, with the great advantage of alleys on the north and east sides. On this lot is to be erected a modern office building, fitted with all the thousand and one improvements and luxuries that go to make up that marvel of American invention, a perfect hive of industry unsurpassed in the world.

And first, it must be fire-proof in the latest sense of the word. But a very few years ago a so-called fire-proof building meant one constructed of beams and cast iron columns, with brick arches sprung from beam to beam resting on the lower flanges. This construction left the entire column and a great part of the beams exposed to view, and what is much more serious, to the possibility of contact with fire. This was the great trouble, for at a comparatively low temperature the iron fails in its carrying capacity, while a sudden cooling by water causes it to break, as was so well exemplified in a large fire in Boston a year ago.

The method of fireproofing now employed consists, we might say, of a skeleton or framework of wrought iron or mild steel, inclosed in a sheathing of porous terra cotta, a material but little known and used ten years ago. Every square inch of the metal work is protected by means of the various shapes made by the terra cotta companies, and all direct communication between the metal and heat is avoided. This porous

tile is made of clay, which before it is burnt is mixed in considerable proportions with sawdust and finely cut straw. During the firing these ingredients are consumed, leaving the material in a very porous condition. Of course, a great advantage is gained in the saving of weight over the old brick arch method. It amounts to a saving of over fifty per cent., thus warranting more economical proportions in the iron framing. Fig. 1 shows sections of interior columns, surrounded by these special shapes.

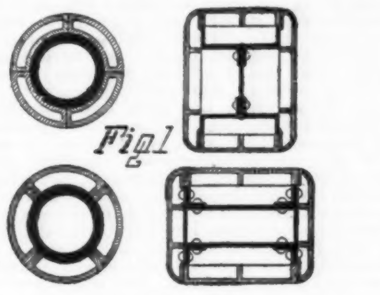


Fig. 1

For floor arches the ordinary flat tile arch is generally used, shown in Fig. 2. The voussoir blocks are cemented together, having radially inclined joints, as in any segmental arch. The skewbacks of the arch take the shape of the iron beams against which they bear, different skewbacks being ready at hand for each different depth of beam that may be found in the floor. An arch may have a 12-inch beam in one side and a 7-inch beam in the other. The lower surfaces of the tile reach about an inch below the bottom of the beam, and a thin piece of tile is slipped in under the

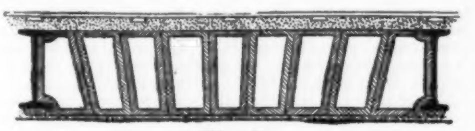


Fig. 2

lower flange of the beam, as shown in the figure, to complete the protection against fire. A coat of cement is given the whole surface, when it is ready for such decorative treatment as may be desired. The beams are thus entirely surrounded by the best known non-heat-conducting building materials, brick, cement and concrete. Special shapes for skewbacks, etc., are shown in Fig. 3. For large spans an arch is often used following the curve of pressure, adding materially to

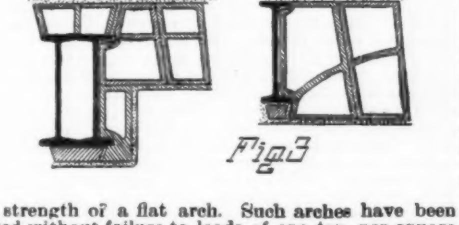


Fig. 3

the strength of a flat arch. Such arches have been tested without failure to loads of one ton per square foot.*

Six or seven feet is the maximum span allowed in the ordinary flat arch construction, and it is here that we get the conditions governing the location of our floor beams and columns. Around the outside of the building, the locations of the columns are, of course, governed by the architectural arrangement of the piers, but they must always be placed near enough to allow the use of an I beam as a girder from column to column, or in special cases two I beams placed side by side, acting as one girder, or in larger spans still a plate, or lattice girder. The "framing plans" are thus worked up, showing the locations of all the columns, girders and joists in a floor plan. The girders run from column to column, and support the joists so placed as to divide the floor space into spans of 5, 6 or 7 feet as stated. These floor beams are generally figured by means of the table of coefficients found in Carnegie's handbook; obtained by multiplying the distributed load which falls to the share of a beam by its length. Such maximum coefficients are given for each size and weight of I beam used.

The floor loads, of course, consist of a dead load,

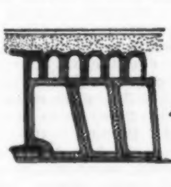


Fig. 4

depending on the weight per square foot of the construction used, and a live load. The maximum possible live load from a crowd of people is figured at 80 lb. a square foot, but we hardly expect to realize that in an office building. For our dead load we have for example:

Flooring, double	7 lb.
Cinder concrete	9 "
4-inch tile filling	12 "
12-inch arch	42 "
Iron	10 "
½-inch plaster	5 "
Partitions, etc	25 "
Total	110 lb.

For marble or mosaic floors add 7* lb. per square foot to the weight given above. We then have:

	Joist.	Girder.	Column.	Footings.
Live	60	45	30	
Dead	110	110	110	110
Total	170	155	140	110

A difference is made in the live load as shown in the table for the reason that a great part of such a moving load is taken up in the vibration of the floor beams, and as it is transferred from joist to girder, from girder to column, and thence down the columns to the foundations, it is gradually lost.

Care must be taken in figuring beams to see that the length is not too great, giving a deflection sufficient to crack the plaster ceiling beneath. About $\frac{1}{30}$ of an inch per foot of clear span is the usual maximum permissible deflection. Under ordinary loads this is attained when the clear span is about 26 times the depth of the beam.

Steel columns are fast superseding the old types of cast columns for many reasons, principally on account of the uncertain factors which enter into the strength of a casting. As far as the metal itself is concerned we can easily obtain such results as our specifications demand; but in the manufacture or casting we run the risk of cold shuts, where the metal unites imperfectly after becoming cooled by running through the moulds, unequal thicknesses in hollow columns, and spongy or honeycombed places caused by the gases. Cast columns must always be examined by the inspectors for such defects, but how sure can we be that such hidden dangers are discovered? I remember a prominent architect telling of the experience of one of his inspectors. He was examining a cast column by tapping or sounding it with a light hammer. Discovering what he thought a suspicious ring, he called the foreman of the yard for his opinion. Of course the latter urged its immediate shipment, declaring it was nothing. Not satisfied, the inspector discovered a very slight mark like a scratch on the outside of the column, and getting a chisel and hammer, what was his surprise to have a piece of very considerable size fly out at the first blow. He had fortunately found a cold shut. This great uncertainty led to the use of a high factor of safety in cast columns, say 8; whereas in box columns of steel plates we use some such factor as 4, or say 12,500 lb. per square inch in short columns, where calculation by the radius of gyration can be omitted. The column weights are thus reduced—a great point in such large buildings as our example.

The subject of the columns and piers of our building is capable of three treatments, each of which is used in its own particular circumstances.

First.—Where the outside piers are entirely of masonry, carrying all weights which come on them by masonry alone. Such construction is used in buildings of moderate height where the material used in the fronts is such that it must be laid solidly in good sized piers—such as granite, stone, or the massive flat brick effect. But in the larger buildings, of which we are particularly speaking, it is the exception rather than the rule in the new construction to rely entirely on masonry piers, except perhaps where we have a very tall building on a narrow lot, so that the piers and a party wall may serve as a *stiffener* to the iron framework inside. The objections to such masonry piers in a case like ours are two fold; first, the modern requirements of plenty of light for all our offices demand that the windows be broad and numerous and the piers narrow. In the enormously high buildings of the present, hardly any masonry construction is strong enough to carry its own weight and the floor loads for so great a height with so small a cross section. In the Masonic Temple it was found that the maximum allowable pressure of 12 tons per sq. ft. on brick work would have been reached at the fifth floor; or, below that level the load exceeded the crushing resistance of the material. Secondly, that large masonry piers take up too much valuable renting space. When the rent of offices is proportioned at so much per square foot, this becomes a matter of much importance to the owner.

Second method is where metal columns are placed inside the exterior piers to carry the floor and roof loads and all weights except those of the masonry facings, which are carried by the piers surrounding the columns. In this case, great care must be taken that the masonry does not touch the columns, in order that the unequal settlement of the metal work and masonry may not cause undesirable strains. On account of the numerous mortar joints the masonry will settle much faster than metal; if then it bears on rivet heads, plates or connections in the columns, we have a heavy strain that has not been provided for. Great care is necessary here to provide sufficient "open joints" at points over cornices, etc., where they will least be noticed, to provide for such settlement. Also where the mass is not homogeneous, as in stone facing and brick backing, the result is likely to be that the stone, with fewer joints, settles less and receives more than its share of the load, producing cracks and spalling off the angles. This was true of the Washington Monument.

The third method is the one becoming more common at present and is the one which perhaps opens the means for building our highest structures. That is, to throw *all* of the weight on the metal columns, surrounding them with an ornamental shell of terra cotta or other light material which is securely anchored to and supported by the columns at the various floors. So that in reality our building becomes nothing more nor less than a vital skeleton of steel, with a pretty wrapper on the outside and a film of plaster and decorative work on the inside. The terra cotta companies design their pieces with special reference to tying them on or suspending them from such a framework. You can see arches innumerable, which to the causal observer seem to support some heavy wall above, to be nothing but a series of hollow tile held by wires or clamps to a beam or girder which really carries all the load, and the massive wall proves to be nothing but a two-inch coating of clay.

What are called "spandrel" beams run from column to column, or pier to pier, over a window space, and hold the arch for the window beneath, and the sill or coping above. Some spandrel sections are shown in Figs. 5 and 6. Fig. 6 shows a section taken through a

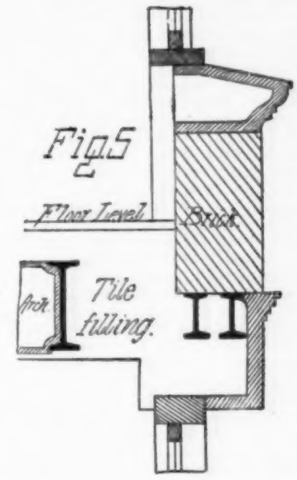


Fig. 5

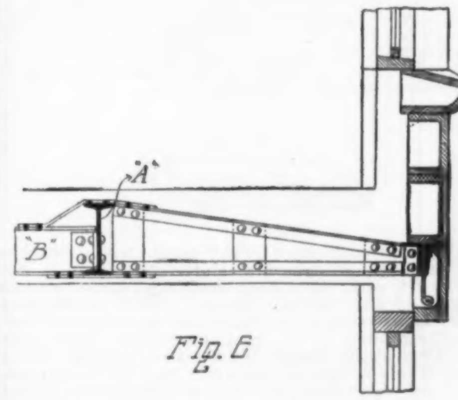


Fig. 6

projecting bay window, which is supported at the various floors by bracketing out from the floor beams. The beam "A" is a main girder running from column to column, "B" is a floor joist.

The conditions often require that a girder strike the column off center, necessitating a bracket on one side of the column to support it. In such cases and in all exterior columns, when the loads are not applied equally on all sides of the columns, we should use a less unit strain, due to eccentric loading. Many, or, in fact, most engineers, disregard this entirely, but in such large buildings it is best to investigate the difference. Rankine's formula can be used, and was found to reduce the unit strain considerably in the Masonic Temple.

Z columns have been used to some extent recently, but do not seem to meet with much favor. They can be used advantageously for small sections, but when side plates must be added the connections become bad, and if figured by the radius of gyration it would appear that a large part of the section at the center of the column is lost. They have also the disadvantage of being rolled by but a few of the larger mills. In this age of push and hurry, the quick delivery of material is an essential point. The demand for structural steel in our country to-day is so great that it is almost impossible to secure such a prompt delivery as is required for the completion of such a building in the specified time. The contracts that are being made in Chicago to-day for some of these large buildings undoubtedly insure the most wonderful construction in point of excellence and short time that the world has ever seen. The Masonic foundations were completed in as many weeks as months were formerly required—and the contractors are under heavy bonds and forfeits to complete their work by specified time. Those who predict the inability of the World's Columbian Exposition management to prepare the buildings in time would do well to learn what is being done in the way of quick and good building, too, in Chicago to-day. It is said of a large building in New York City that the masonry for the twelfth story was laid before the mortar of the first floor level was dry.

In connection with the design of the columns and floor beams, we must not forget to provide vertical bracing for our building. Who would think of building a bridge without providing for the wind pressure in both vertical and lateral wind bracing? and yet how many high buildings have been designed with no such provision. The horizontal bracing we may safely omit, as the many floor beams form a very stiff system in this direction, but the vertical bracing is only just commencing to be recognized as of quite as much importance as in a bridge. One great objection to this vertical bracing is its interference with the plans of the rooms, offices, and windows, running diagonally from floor to floor and column to column, just where we may want to place our halls or doors, or, perhaps, leave entirely open as in a banking floor. But, as

* Some very interesting tests of fireproof arches were recently published in the *American Architect and Building News*. These tests were made in Denver, Col., for the Denver Equitable Building Co., under the supervision of a board of architects. Some astonishing results were obtained through the use of a porous tile arch, in which the hollow spaces of the arch run crosswise from beam to beam, instead of parallel to the beam, as shown in the above figures. The arches were sprung from beams placed 5 feet centers and among the results were the following: A load of 15,145 pounds of pig iron was carried successfully for two hours; afterward broken by a ram. Arch was given eleven applications of water, and was uninjured after twenty-three hours, and a continuous fire under it for twenty-four hours had practically no effect, as it sustained a load of 12,500 pounds on a space of 3 feet wide at center of arch. For full account of tests, see No. 796 of the *American Architect and Building News*.

* An eight inch arch weighs 29 lb. per square foot and can be used up to spans of 6 feet. A nine inch arch weighs 33 lb. A ten inch 37 lb. Small tie rods are run from beam to beam every few feet to strengthen the arch.

more and more of the constructional work of our large buildings is being put in the hands of engineers, as opposed to the pure architects, just so will they insist that the *primary* consideration in a building is its construction, and hence the artistic portion of the design must adapt itself to the more essential features. In many of the offices of the more prominent architects we find two distinct corps of workmen; the architectural draughtsman, pure and simple, for all decorative and designing work, and the engineers, who care for the more substantial problems. In such an office the two kinds of work can be carried forward simultaneously, concessions made on both sides, and a satisfactory medium reached.

Many interesting details have to be studied and definitely settled before the foundation plans can be decided. Our partitions are made from the same character of hollow tile as is used in the fireproofing of the columns and in the floor arches. They can be readily torn down and shifted to suit the tenant, without injuring the construction a particle, as they are seldom used to support any weight. Our interior court must be a permanent feature in the design, to give plenty of air and light to the inside offices, its walls being faced with marble or glazed brick. Sufficient elevators must be provided in order to insure rapid service, and beams figured to support the sheaves which carry them. In the Masonic Temple fourteen passenger elevators are provided, and two more are used for freight exclusively. These necessitate an ejector pit in the basement and a sufficient water supply if the elevators are hydraulic.

In our particular example a few details out of the ordinary run in office buildings are found. The seventeenth and eighteenth floors are devoted to Masonic purposes. On the seventeenth we have two large drill rooms, down either side of the court. This requires that an interior row of columns be omitted in the center of each drill hall. This is provided for by supporting the floors by lattice girders, which run between the columns at either side of each hall. From these girders spring the gable roof trusses, with an arched system spanning the lodge and banquet rooms on the eighteenth floor. On the twentieth floor we have the large water tanks to supply the building and elevators. The top of the twentieth floor, called the "deck roof," has a four foot parapet all around the edge, the whole covered by a large curved glass roof, serving as a summer garden and place of observation. The gable roof running up to the parapet is constructed of book tile laid on T iron, as shown in Fig. 7, on which fancy tile, iron or slate may be fastened.

Fig. 7

All these details must be well determined, including the weights of all structural material, wind, snow, elevator and tank loads, floor loads, etc., before we can commence the "column sheets." These sheets form a tabulated list of all the loads that come on each column, beginning at the roof and adding in the loads that come at the successive floors as we descend. From these sheets we can see the exact load that each column must carry at each floor, and the sectional area required; and finally the total load transferred to each footing.

Now comes the delicate problem; especially in Chicago and vicinity, where the underlying strata consist of layers of clay or hard pan from three to seven feet thick, lying perhaps 10 or 12 feet below the street levels. By means of compression tests and government experiments, as well as individual tests, it is found that this layer of clay will safely carry not more than three, and at a conservative estimate say two tons per square foot, allowing for a reasonable settlement.

This settlement is the great evil that must be provided against, and the case of the government building well exemplifies its evils. This building was built 14 years ago, and the government superintendent of buildings recently stated that it had settled 18 inches in places, and the movement was still progressing. Numerous cracks and bursting of water and steam pipes, and of late the falling of a skylight, are some of the evidences of this movement.

The investigation of the soil's compressibility leads to the conclusion that if we wish to procure *uniform settlement*, all parts of the foundation areas must be exactly proportioned to the loads they have to carry. The footings themselves must be of sufficient strength to distribute the applied loads over the requisite area. In this way only can we obtain satisfactory results.

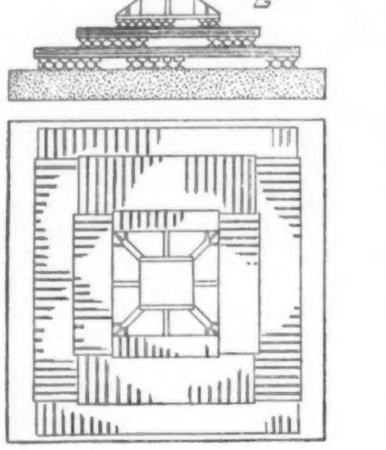
The problem has been most successfully solved within the past few years, as is well illustrated by an example of the past few months. Extensive foundations on the old plan had been completed some years since for a large mercantile building. When the foundations were completed, work was stopped. A short time ago the land was sold as it was and plans were immediately made for a new building. The first thing done was to rip out all the old piers at a cost of many thousand dollars. This old system consisted of stone piers made of successive layers of large stones stepping out till a sufficient base was obtained. The objections to these were many. They are expensive, as heavy dimension stones are necessary; they are of great weight, which we wish to avoid, and very bulky, taking up much valuable space in the basement, which is quite as desirable as office space for restaurants, etc., and especially for the large boiler and electric light plants necessary in such large buildings. It is even customary now to use all available space under sidewalks and alleys for such plants.

The new type of foundations here described are now used very extensively where no very stable bottom is reached. It consists first of a layer of concrete, about 2 feet thick, upon which come layers of I beams or steel rails, each layer laid transverse to those just below or above it. The spaces between and around these rails are rammed tight with concrete, preserving the iron from the action of air and water.

The layers decrease in area as they ascend, and the rails are spaced or calculated in regard to size according to the bending moments arising from the load and length of rail. The whole forms a solid grill work of steel, protected and stiffened by the concrete. On the top layer the casting to receive the column is placed as shown in Fig. 8. With the old pier construction a pile of stones would be necessary some 10 to 15 feet high, while here we obtain a far better result with a height of 3 or 4 feet. These footings are often made 15 to 20 feet square, and in some cases completely cover the lot.

We must not forget that our footings have been designed for the *final* loads that rest on them, and at all points of the construction we must strive to keep the same relation between the weights on the piers as we will have in the completed building, if we wish a uniform settlement. This was well exemplified in the case

Fig. 6



of the Auditorium tower, which extends many stories above the main building. Here, the tower foundations were loaded with various weights of pig iron at the different stages of construction, in order that the proper excess on these piers, as in the final weight, should be preserved. Even this great tower, built with all possible precaution and after careful tests of the ground beforehand, has settled more than originally allowed for. It is needless to say that these foundations require the nicest engineering skill. When piles can be used to advantage the labor is simplified.

One of the most delicate problems is in constructing a very heavy building by the side of one already completed, so that the latter will not suffer by settlement due to the additional weight of the new building. Such settlement is shown in a remarkable degree in the case of a very badly cracked and disfigured front of a building next the Auditorium before mentioned. The front is at present being rebuilt.

In such a problem, the old wall is carried on timbers supported at either end by jack screws. The new wall is now put in, and with its foundations settles gradually, while the jack screws are turned as occasion demands to keep the old wall at its proper level. This may be continued till all settlement ceases, when we may remove the jack screws one by one and substitute a new wall under the old building.

If we cannot have access to the basement of the old building, or underpinning in the previous manner is impossible, cantilever foundations may be employed as in the well known Rand-McNally building. The old foundations must not carry any additional weight, and yet we cannot substitute new ones as before described. The accompanying figure will sufficiently explain it-

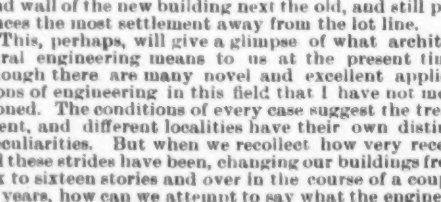


Fig. 9

self. The usual type of footings is employed, I beams or rails and concrete; on these come high cast shoes supporting a cantilever girder, which supports the column and wall of the new building next the old, and still produces the most settlement away from the lot line.

This, perhaps, will give a glimpse of what architectural engineering means to us at the present time, though there are many novel and excellent applications of engineering in this field that I have not mentioned. The conditions of every case suggest the treatment, and different localities have their own distinct peculiarities. But when we recollect how very recent all these strides have been, changing our buildings from six to sixteen stories and over in the course of a couple of years, how can we attempt to say what the engineering possibilities still in store for us may be?

I might mention perhaps the most daring design yet put before a public already accustomed to monstrosities. A prominent New York architect and engineer has designed a building of 32 stories, and 442 feet high. The study of this building is given in the New York *Sun* of February 8, 1891; it shows a structure whose foundations cover the entire surface of a lot 75 feet square, constructed of steel columns and girders, with facing walls only of granite, brick and terra cotta. The weight is uniformly distributed on bed rock if possible to reach; or if not, on piling or iron grillage.

Let us hope that our houses may be builded on a rock, and that the storms as well as the quiet tide of advancement of many generations yet to come may see our monuments of engineering skill and grandeur still the wonder and admiration of a busy world.—*The Technic.*

THE THIES PROCESS OF TREATING LOW GRADE AURIFEROUS SULPHIDES.*

By Mr. A. THIES, Concord, North Carolina, and Mr. W. B. PHILLIPS, University of Alabama, Tuscaloosa, Alabama.

THE Thies process is in brief the treatment of dead-roasted auriferous concentrates (pyrite, sometimes also chalcopyrite, as at the Phœnix mine, Cabarrus Co., North Carolina) with nascent chlorine, without artificial pressure or exhaust, in lead-lined iron cylinders; the throwing of the mass on a sand filter and the quick filtration and precipitation of the gold chloride with fresh and active ferrous sulphate. The gold is precipitated as metallic gold of a reddish-brown color, which, after being allowed to settle completely, is collected, washed, dried and melted with soda and borax in graphite pots and cast into bars. The efficiency and economy of the process are such that, in working on a large scale, crude ore of the assay value of $4 per ton, carrying about one-third of its gold free and two-thirds in sulphurets, can be profitably treated. At the Haile mine, Lancaster County, South Carolina, 36,000 tons of such ore have been successfully treated, and it is now mined and treated at the rate of 80 tons per day of twenty-four hours. It should be observed at the outset that the chlorination system here used is not patented. Any one is free to employ it; and therefore what is said of it in the present paper is without any bias of commercial interest. It is the second attempt to introduce into the Southern gold fields, on a large scale, the chlorination of roasted ore in place of amalgamation, and as an adjunct to amalgamation before roasting. The uniform and most gratifying success attending the use of this process for several years at the Phœnix mine induced the owners of the Haile property to introduce it at these mines under the personal supervision of Mr. A. Thies. Without severing his connection with the Phœnix Company, he took charge of the Haile mine in January, 1888, where he operated twenty stamps from that time to January last, and since the latter date has added forty stamps, making a present total of sixty in operation. By this process of chlorination there have been treated since 1880 at the Phœnix mine 5,000 tons of concentrates, and at the Haile, since May, 1888, the date of the beginning of the work here, 2,353 tons.

This statement is sufficient evidence that the process is conducted upon a commercial scale, and has long since passed the experimental stage. There is now no more reason to doubt its success as applied to low-grade auriferous sulphides than to doubt the success of the Thomas process in the manufacture of steel. Nor is it too much to claim for it that it stands metallurgically toward the other and older processes for the extraction of gold as the Thomas process stands toward the other and older processes for the manufacture of steel. Both these processes were successfully applied about the same time. They are vital improvements upon the ideas of previous unsuccessful applications; and they deal with materials that hitherto had baffled all attempts at utilization, the one with high phosphorus iron ores and the other with low-grade sulphuret gold ores. In order to realize the especial significance of the Thies process to the metallurgy of gold, it is only necessary to recall the history of Southern gold mines for the past fifty years. It is a history of disappointed hopes. The capital invested in such mines has been, to say the least, extremely unproductive. Even during the last six or eight years, when any one who chose might have ascertained for himself the true method of treating these ores, the old state of affairs has continued, and the old story has repeated itself. The elements combined in this successful solution of the problem are concentration, roasting and chlorination. They go hand in hand; each is incomplete without the others. But what distinguishes this process from all others is the method of applying the chlorine to the roasted ore, of which we shall speak later. Since a complete account of the process requires some notice of the conditions under which it is employed at the Haile mine, this paper will briefly describe the geological occurrence of the ore; the operation of mining and transportation to the mills; and the milling and concentrating; after which an account will be given of the roasting and chlorination, including the delivery of the gold solution to the precipitating vats, and finally the precipitation, collection, and smelting of the gold.

Geological Occurrence of the Ore.—The ore at the Haile mine is a mixture of pyrite and stratified talcose slate. The strike of the strata varies from N 52° E. to N. 73° E., and the dip (northwesterly) from 45° to 75°. The foot wall is soft talcose slate, colored yellowish, brownish, and red by iron salts, and showing cross joints. The hanging wall is (often, if not always) greenstone. From the foot wall toward the hanging wall there is a well marked increase in the hardness of the ore; bands of siliceous matter appear, and veinlets and veins of almost pure pyrite, from the thickness of ¼ inch to 1½ foot. These streaks of pyrite cut across the slates in all directions and are also at times parallel to them. Now and then masses of considerable hardness are also found near the foot wall, but whether they occur here or in the vicinity of the hanging walls, they are evidently derived from the talcose slates. It is believed that whatever be the earthy material mixed with the slates in the ore-bearing mass, it has been derived from the slates themselves. Even the very siliceous material found near the hanging wall, and bearing no close resemblance to the slates either in color, hardness, or stratification, was doubtless derived from them. Several dikes, seemingly of diabase, cross the slates at irregular intervals. Between these dikes lie the immense deposits of talcose slates, impregnated with gold-bearing pyrite and with more or less free gold. The free gold is generally fine. Wherever the slates are rich enough in free gold and in pyrite, they are mined. The reacher streaks are of various widths, from 2 feet to 30 feet, and are of the same general character as the main body of the slates. In immediate proximity to the dikes, as well as to the hanging walls, the slates are, as a rule (with some exceptions), richer than elsewhere. As to the correlation between the dikes and the ore masses, little will be said here. That the dikes do influence the richness of the ore favorably seems to

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be beyond question, but it is not so easy to say why. Nor can we speak positively as to the nature of the dikes themselves. They stand nearly vertical; they cut the strike of the slates nearly at right angles; they exercise a favorable effect upon the richness of the ore; but whether they are strictly diabase or not, and whether they are of plutonic origin or not, will not be discussed here.

Mining and Transportation to the Mills.—In such thick masses of ore, choice must be made between taking out all the ore (sustaining the walls with timbers) and taking such ores as can be extracted, using as little timber as possible, and leaving pillars. The first plan is not to be thought of here, on account of the varying value of the ore, the enormous amount of timber required and the expense connected with keeping it in sound condition. The other plan was therefore adopted and has worked satisfactorily. The levels are driven from 60 to 70 feet apart and connected at different points by winzes which serve during stoping as ore shoots. Between these winzes main pillars are left, while the ore is stoped on each side of the pillars from hanging to foot, leaving sufficient solid ore against the hanging wall to insure safety. Of the mines partly opened and worked in earlier years, the Bequelin (formerly known as the Blauvelt) is now in active operation. The main shaft has reached a depth of 194 feet on the dip of the ore, of which 15 feet are used for a sump. The levels are driven east and west from the shaft at intervals of 60 feet, and the ore is trammed from chutes at the 180 foot level to the main station to be hoisted by double skips to the surface. From 80 to 100 tons are hoisted in twenty-four hours. The system of mining would require for its full discussion a separate paper. It may be characterized here as the pillar system (Pfeilerbau), generally employed when excessive timbering is to be avoided. The drilling is done by double hand, single hand, and machine drills. For this latter purpose there are four Ingersoll-Sargeant drills of $3\frac{1}{8}$ inch cylinder, now used entirely for development work. The plant at the Bequelin shaft consists of two boilers, of 90 and 35 horse power respectively, which, under full headway, carry from 75 to 80 lb. steam pressure, consume about six cords of pine wood in twenty-four hours (at a cost of \$1.40 per cord, delivered), and furnish steam to one 20 by 30 Ingersoll air compressor, one 40 horse power Dickson reversible link motion hoisting engine, one 20 horse power crusher engine for a 20 by 10 Blake crusher, and one No. 9 Davidson mining pump, of 200 gallons per minute capacity. The ore is hoisted in skips which discharge automatically upon two grizzlies and thence to the crusher. One man can load 60 tons per ten hours on the skips, which hold 1,500 lb. each. The grizzlies have each a square surface of 32 feet, and the bars are set $1\frac{1}{2}$ inches apart for the "shaft smalls," while the coarser ore goes directly to the 20 by 10 crusher. The grizzlies and crusher discharge into an ore bin holding 30 tons. From this bin the ore is hauled by a narrow gauge locomotive $\frac{3}{4}$ mile to the mill; a train load being 7 cars carrying 3 tons each. An engine driver and two boys look after the loading of the ore from the bin on to the cars, the transportation to the mill and the discharging into the mill bins. They also keep the track in repair.

Milling and Concentrating.—There are at present 40 stamps working; 20 more are up, but not quite ready to begin dropping. The average amount of ore crushed per stamp per 24 hours during the last four months is 2·01 tons. The stamps weigh 750 lb. each, and drop $5\frac{1}{4}$ inches 84 times per minute. The screens are 36-mesh, of brass wire. Formerly 40-mesh slotted Russian sheet screens were used, but these were discarded in favor of the wire screens, the latter not only possessing greater durability, but giving a far more uniform pulp for concentration. The average life of the wire screen has been six weeks, while slot screens often had to be thrown out in fourteen days. The average amount of water used per stamp is $3\frac{1}{2}$ gallons per minute, and the average consumption of quicksilver per ton of ore is 0·35 ounce. The average wear and tear of shoes and dies per ton of ore stamped is 1·3 lb. The area of inside plates per battery of five stamps is 1·75 square feet, and of outside plates 32 square feet, with a 2 inch inclination to the foot. There are three boilers of 50 horse power each and one Harris-Corliss engine of 150 horse power. The forty stamps are run with a steam pressure of 50 lb. The mill is of the back to back type, thirty stamps on east and thirty stamps on west side. Each double battery has its own cam shaft, which is driven by belt from a pulley on the shaft common to all the stamps on the same side. The east battery shaft and the west battery shaft are driven by steel bevel gearing from the main shaft. The railway cars are bottom dumpers, and discharge their ore on the iron plated comb, dividing the east side bin from the west side bin. These bins hold 150 tons each, and discharge their ore into Hendy self-feeders. The angle of inclination of the bin bottom toward the self-feeders is 60°. The battery tailings are conveyed to the concentrator through open launders 8 by 10 inches, with cross riffles, 1 inch high, every 8 to 10 inches. Total length of launders, 78 feet; inclination, $\frac{1}{2}$ inch per foot. The launders discharge into a box from which runs a series of small launders at right angles to the main launder, to each concentrator. There are sixteen Embrey end shake concentrators, eight to each twenty stamps. The distribution table for the battery tailings is provided with an amalgamated copper plate for saving any free gold, amalgam or free quicksilver which may escape from the outside battery plates. The belts are set with $2\frac{5}{8}$ inch inclination, and travel 5 feet per minute. The number of strokes is 192 per minute. The yield in concentrates per ton of ore stamped averages 9 per cent.—*i. e.*, for each $11\frac{1}{9}$ tons stamped, there is a yield of 1 ton of concentrates. The loss in sulphurets is about 10 per cent.

The fire assay value of the ore delivered to the stamp is \$4.50 per ton. The mint returns of bullion give \$3.90 per ton of ore treated, of which \$1.45 is to be credited to the stamps, *i. e.*, to free gold, and \$2.45 to sulphurets. Taking the value of the ore at \$4 50 and the actual yield in bullion at \$3 90, we have an indicated loss of 60 cents per ton, or $13\frac{1}{3}$ per cent. Taking the yield in free gold at \$1.45 per ton from an ore worth \$4.50 per ton (or approximately 32 per cent.), we have 68 per cent. to be sent into the concentrates. But the total yield in free gold and in gold from the sulphurets is \$3.90 per ton, so that the ratio of the free gold saved to the total amount saved is approximately 38 per cent., and of the combined gold 62 per cent. An ore of this kind therefore carries about one-third of its gold free and about two-thirds combined. We have used the term combined gold to express the condition of the gold that is not free. Whether the gold that is not free is chemically or mechanically diffused in the sulphurets, or both, is not known. Much has been written upon this subject; but as yet, we are not warranted in adhering positively to either view. One thing appears certain, viz., that no matter what may be the state of the gold in such material, it must be thoroughly roasted before it can be profitably extracted. From the 80 tons of ore stamped per twenty-four hours, there are obtained $7\frac{1}{2}$ tons of concentrates, which gives as the yield of each concentrator a little less than one-half ton. The concentrates are piled in a shed, and thence conveyed by rail to the furnaces, a distance of 1,200 feet. The average assay value of the raw concentrates has been, for the last twelve months, \$30 per ton. This corresponds closely to the estimated value. Assays vary from \$25 to \$35 per ton of 2,000 lb. The percentage of sulphur in the raw concentrates varies from 40 to 45 per cent. In roasting, this is brought down to from 0·25 to 0·40 per cent., and the value of the material per ton is increased by one-third—*i. e.*, a raw concentrate of \$30 becomes a roasted material of \$40 per ton.

Roasting and Chlorinating.—The roasting plant consists of one pan revolving furnace, two double-hearth reverberatories, each of 400 square feet roasting surface, and one American Spence furnace. The capacity of the pan furnace for twenty-four hours is $2\frac{1}{2}$ tons of roasted ore (equal to $3\frac{1}{3}$ tons of raw concentrates), and that of each reverberatory furnace 2 tons of roasted ore (equal to $2\frac{2}{3}$ tons of raw concentrates). The yield of roasted ore per day of twenty-four hours is $6\frac{1}{2}$ tons from one pan and two reverberatories. The consumption of wood is one half ton for each furnace per ton of roasted ore. Each furnace is attended by four men for twenty-four hours, who do all the work of charging, firing, and rabbling, and also deliver the roasted ore on the cooling floor. They are paid \$100 per day of twelve hours. The wood used is pine, and costs \$1.40 per cord delivered. Mr. Spilsbury, in a paper read before the Institute in 1883, puts the roasting capacity of the reverberatory furnace at 6 tons to 10 tons per day of twenty-four hours. This is not practicable when the product is to be so roasted as to be suitable for chlorination. No such feat has been accomplished in that kind of roasting by any furnace, modern or ancient, automatic or otherwise. It should be added that the roasting to which Mr. Spilsbury refers was followed by amalgamation. In November, 1889, an American Spence furnace was built, but the expectations entertained concerning its operation were not realized, and the furnace, after many unsatisfactory attempts, has been idle since. The difficulties encountered were, first, the matting of the iron rakes, whereby they were prevented from swinging on their axis; and, secondly, the banking of the ore on both ends of the shelves. The first difficulty, viz., the clogging of the rakes by the fine ore, was in part overcome by providing the rake with a sheet iron hood. But although this gave some help, it did not altogether remove the trouble. The swinging of the rakes on their axis is a *sine qua non* of their efficiency, and just in the measure in which this is prevented, in the same measure is the roasting hindered. If the rakes cannot swing they cannot rabble the ore, and without this no thorough roasting is possible. This trouble is intimately connected with the second difficulty, viz., the banking of the ore at the ends of the shelves. Under the present construction of the furnace the differences between the length of the rods which move the rakes is 6 inches, so that when the ore drops from a shelf to the one underneath, the rake on the lower shelf is 6 inches in advance of the rake on the upper. This distance is not sufficient to prevent the fine red-hot ores from falling upon the lower rake as they are discharged from the upper shelf. These ores move very easily—they may almost be said to flow; and they begin to fall through the opening when the rake is 12 to 14 inches from it. In this way the ore falls in front and on top of the lower rake, and is pushed by it toward the end of the shelf. In its back stroke, the rake, being clogged by the fine ore falling on it, cannot take with it all of the ore that it pushed forward. Some is left, and the pile grows larger and larger, until finally the entire end of the shelf is full of ore. The alternate pushing and pulling of the clogged rakes causes a banking of the ore at both ends of the shelves. After several weeks of continual trouble and worry it was finally decided to discontinue the attempt to utilize this furnace for chlorination roasting.

The principle on which the Spence furnace works is correct in every detail, and it is undoubtedly the proper furnace for roasting coarse ores for smelting purposes where a complete elimination of the sulphur is not wanted. A chlorination roast, however, must be a uniform dead roast, and no furnace which will not deliver material in that condition can be used. From the furnaces the ore goes to the cooling floor, where it is allowed to cool; then it is dampened with water and elevated to the chlorination floor.

The chlorination plant consists of two chlorinators, eight filters, two storage tanks for the filtered solutions, thirteen precipitating tanks, two settling tanks for precipitates, a storage tank for sulphuric acid, and a tank for preparing the ferrous sulphate (copperas). The following is a brief description of the barrel chlorination as in practice at the Phœnix mines, North Carolina, and the Haile gold mine, South Carolina: The cast or sheet iron cylinder (chlorinator) is 42 inches in diameter by 60 inches long. The heads are cast and securely bolted to end flanges and provided with tight and loose pulleys. The bung for the introduction of the roasted ore and chemicals, 6 inches in diameter, is provided with a lead-lined cover, which, before rotation, must be closed hermetically. The interior of the cylinder is lined with sheet lead of 10 to 12 lb. per square foot. The capacity of the chlorinator is from 1 to $1\frac{1}{4}$ ton of roasted ore. Before introducing the ore, the chlorinator is charged with from 100 to 125 gallons of water, or, I might say, with enough water to make an easy-flowing pulp. This done, the roasted ore is introduced, half the requisite quantity of sulphuric acid is then poured in, and lastly, half the required chloride of lime, when the bung hole is closed and the chlorinator is set in motion at the rate of fifteen revolutions per minute. For Phœnix ores I use 40 lb. of chloride of lime and 50 lb. of commercial sulphuric acid per ton of roasted ore; but I charge 20 lb. of chloride of lime and 24 pounds of acid first, rotate for three or four hours, open the bung and charge the other half, having found better results in dividing the chemicals. Rotate for two or three hours longer, and if, by the aid of the lead valve, free chlorine is found present, the cover is removed from the bung hole and the chlorinated ore is thrown on a shallow filter, 6 by 8 feet, provided with a 5-inch filter bed, over which the pulp spreads to a thickness of about 4 inches. The filter, before the ore pulp is thrown on it, is first flooded with clear water from below, and when the water stands over the filter the discharge hole is opened, so that the water acts as a cushion against the ore pulp, prevents the packing of the filter bed and admits of a free filtering. When the chlorinator has been emptied on the filter the cork is removed and the solution allowed to pass into a stock tank below. As soon as the first solution has passed through, so that the ore surface is exposed, from 3 to 4 inches of water is added over the whole surface; and when this is filtered through and the ore surface exposed again the whole space, above the ore, about 11 inches in depth, is filled, which, by practice on Phœnix ore, has proved sufficient to remove all the chloride of gold; but should there be still a reaction with ferrous sulphate, more water must be added.

The filters are lead lined, 18 inches deep, and have a fall of 1 inch toward the outflow. The bottom is first covered with perforated glazed tiles or clay or mineraline, which is impervious to the action of acids and chlorine. On this rests the gravel filter bed, which is topped off with ordinary clean river sand. To prevent the filter from getting an uneven surface, longitudinal $1\frac{1}{4}$ inch wooden slats, 8 or 10 inches apart, keep it in place. The filtering should be accomplished as quickly as possible, but, as this depends generally on the fineness of the ore treated, no rule can be established. As long as the solution shows the presence of chlorine when the last wash water has passed through the filter, there is no danger of not having clean tailings. The solutions accumulating in stock tank are let off into smaller tanks for precipitation with ferrous sulphate, which always should be regenerated, if not active, so as to destroy any ferric sulphate. Care should be taken by examining, after twenty-four hours, to ascertain if all the gold has been precipitated, as losses have occurred by a partial precipitation. The tanks for precipitation should not be too deep; a convenient size is 6 to 8 feet in diameter and 3 feet high, holding the solutions from about 3 tons of roasted ore. A sufficient number should be on hand to allow the precipitate at least three days to settle. After three days' settling in shallow vats, the supernatant liquor can be drawn off and fresh solutions added for precipitation. At the Phœnix, the liquor is passed over metallic iron and the copper is recovered as cement. From the precipitating tanks the precipitate is finally collected, washed as clean as possible to remove the iron salts, dried and melted. The amount of chloride of lime and acid used at the Phœnix I have stated as 40 and 50 pounds respectively, which is due to the presence of an appreciable amount of chalcopyrite. An excess of acid should always be used so as to convert all the lime into a sulphate to remain in the filter. The solution should be slightly acid. If neutral, soluble chloride of lime will cause a bulky precipitate with ferrous sulphate. At the Haile mine, where I have to deal with a pure "iron sulphuret," I use at present but 10 pounds of chloride of lime to 15 pounds of acid, and treat 4 tons of roasted ore in two chlorinators during ten hours, and I have not failed to extract 94 per cent. of the assay value. The Haile mine ores, which have been so long the bugbear for economic treatment, and on which so many experiments have failed, are offering no obstacles to the barrel chlorination, and are cheaper and easier to chlorinate than the Phœnix ores.

As the success of chlorination, by whatever process, depends on a thorough roast, assuming that we have clean concentrates, it is of the utmost importance that the roaster should have some guide to go by, and to this end, I let him test every charge before drawing by a bright field iron rod. A small portion of the roasted ore is boiled in water and stirred with the bright iron. The least trace of sulphates will stain the iron—a sign for the workmen that the roasting is not completed. At the Phœnix, I use a revolving pan furnace of 12 feet diameter, with a short reverberatory attached. From two working doors the roaster can rabble the ore. When a charge is finished, the ore is discharged through the hollow axis on which the pan revolves into an outer circle below, and is then removed by scrapers attached to the bottom of the pan into a car, and delivered to the cooling floor, from which it is elevated into the chlorination house. Such a pan furnace roasts 1 ton of raw ore in twelve hours, with a consumption of three-eighths of a cord of wood and 90 cents for labor. The power necessary to drive the pan is a small item, and will not exceed 25 cents per ton of raw ore. At the Haile mine, a double reverberatory furnace furnished 2 tons of roasted ore every twenty-four hours, with an average consumption of 1 cord of wood at \$1.25 per cord, and four laborers. The cost per ton of roasted ore amounts to $\$2.62\frac{1}{2}$. The cost of chlorination by the barrel process depends chiefly on the number of tons chlorinated per day. Two men can easily chlorinate 4 tons in ten hours, elevate the ore and clean out the filters, of which I have four to each chlorinator; and having arranged on this basis the work at the Haile mine, the cost for chlorinating 4 tons daily is as follows:

40 pounds of chloride of lime at 3 cents	\$1 20
60 pounds of sulphuric acid at 2 cents	1 20
2 laborers at 90 cents	1 80
1 chlorinator man	2 00
Motive power	0 50
Total	\$6 70

or $\$1.67\frac{1}{2}$ per ton. Add to this $12\frac{1}{2}$ cents for sulphuric acid for making sulphate of iron, and 20 cents for repairs and wear, which is more than liberal, and we have the sum of \$2 per ton for chlorination, or $\$4.62\frac{1}{2}$ for roasting and chlorinating 1 ton of roasted ore, representing $1\frac{1}{3}$ tons of raw iron pyrites. Inside of seven hours from the time the ore is in the chlorinator,

the solutions are ready for precipitation and the tailings are clean. The wear on the inner lead lining of the chlorinators is inperceptible; a chlorinator in use at the Phœnix for over five years does not show any wear on the lead. That the barrel chlorination has advantages over the Plattner process cannot be gainsaid, and its successful working here and at the Bunker Hill, Amador County, California, where it surpassed the Plattner in results, will undoubtedly lead to its adoption in regions where the auriferous sulphurets are an important factor in the production of gold.

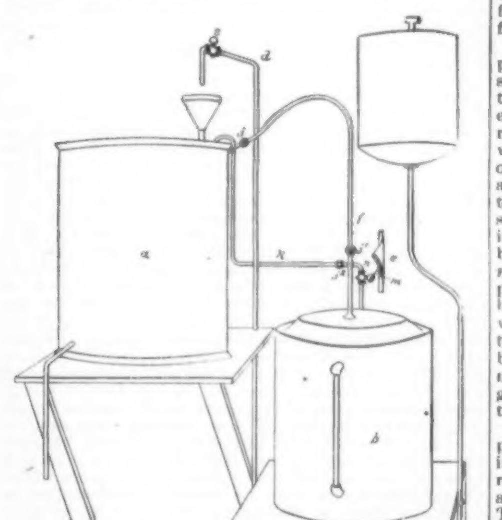
Precipitation, Collection and Smelting of the Gold.—The ferrous sulphate employed as a precipitant should be used fresh, and to this end it is made up fresh for each day's run. It is easily prepared from one day to another. As already observed, care must be taken to see that the precipitation is complete by testing the solutions about twenty-four hours after precipitation. Generally, the total absence of chlorine and a sweetish odor are fair indications of a complete precipitation after a thorough stirring with ferrous sulphate. At the end of a month's work, or whenever it is deemed necessary, the completely settled precipitate is taken up from the precipitating vats into small lead lined tanks two feet by four feet in size and two feet deep, in which it is allowed to settle again for twenty-four hours. The supernatant liquor is then siphoned out, and the precipitate is washed with boiling water until freed from most of the iron salts. It is then collected on filters, dried and melted in Dixon crucibles with borax and soda, and shipped to the United States Assay Office at Charlotte, North Carolina. Its fineness varies between 975 and 985. The successful treatment of 2,353 tons of concentrates from the Haile mine by this process is all the more gratifying because of the failure of all other processes here to work at a profit. It is commended to those who have to deal with large quantities of low grade sulphurets in the belief that it will solve their difficulties, and enable them to work such ores profitably. For simplicity, cheapness and adaptability to such ores, it cannot be too highly praised.

CONSTANT FEED APPARATUS FOR DISTILLING WATER.

IT is a common practice among druggists to obtain the *aqua pura* and *aqua distillata* required in making their preparations from either the pump or hydrant, and others seem to think that filtered water will answer these requirements. Distilled water is not only absolutely necessary for pharmaceutical purposes, but for general chemical and analytical processes as well. It has been my experience that the methods for producing distilled water as usually found in the pharmaceutical and chemical laboratories are not only tedious and expensive, but often inadequate to produce the required amount. In my own experience in pharmacy and the laboratory, there has been no more vexatious problem to solve than how to provide sufficient distilled water with economy of time and expense.

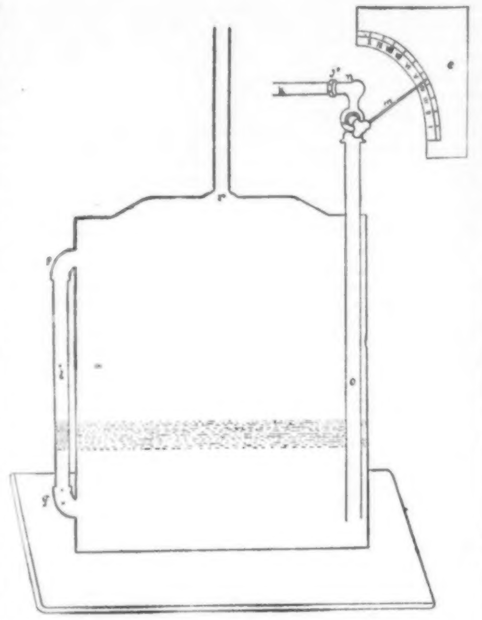
Some few years since I devised and constructed an apparatus which has been entirely satisfactory, and requires so little attention, and withal is so economical to operate, that the distilled water question has been practically solved for our laboratory. For the benefit of those encountering the same difficulty, I give the construction and operation of the apparatus in detail.

The drawing shown is an outline view of the still as it stands in the laboratory. The condenser, *a*, stands on a shelf fastened to the wall, *b* is the boiler or evaporator, and *c* a gasoline stove supported on a table, while *g* is the gasoline tank. To the boiler is attached the water gauge, *i*, while the steam pipe, *f*, passes to the rear of the condenser. A siphon pipe, *k*, leads the hot water from the top of the condenser to the bottom of the boiler, and the feed is regulated by



the gauge cock at *e*. Cold water is introduced into the condenser through the pipe, *d*, which terminates in an ordinary bent gas burner, *s*, and there is an overflow pipe from the condenser not shown in the cut; *j*, *j'*, *j''* are ½ in. brass pipe unions.

The gasoline stove, which is considerably cheaper to operate than a gas burner, is of the single burner type. The boiler resting on this is made of planished tinned sheet copper of the thickness ordinarily used by tinners, and has the tinned surface turned in; it is 12 in. high by 10 in. in diameter. Both top and bottom of boiler are pressed copper plates, such as are employed for the bottoms of coffee boilers. The bottom should have the *concave* surface turned out so as to catch the flame and heat from the stove, while the *convex* surface is turned outward on the top. On what is to be the front of boiler shell, and at a distance of 1½ in. from both the top and the bottom, two holes should be punched on a vertical line, large enough to admit a ¼ in. pipe elbow. These elbows should be soldered on from the inside before the top and bottom are fastened



in place. After completing the boiler, a glass tube, *i*, of a diameter to snugly fit the openings in the elbows, should be cut about ⅝ in. longer than the distance between the edges of the elbows, and then fastened in place with a suitable cement. In this case dental cement mixed with phosphoric acid was employed. This will make a watertight and reliable gauge.

In the center of the top is punched a ⅜ in. hole, and a piece of brass pipe of the same diameter and 6 in. in length is soldered in so as to project not more than ½ in. in the boiler, and an ½ in. brass union is fitted to the end for attaching the steam pipe leading to the condenser. Brass unions are preferable, as they need no packing and do not corrode so readily. The condenser in this case is 11×14 in., made of zinc and contains the usual coil of lead pipe. I have, however, suggested the use of a five gallon cask or even of a lard can, with a coil of ⅜ in. lead pipe about 20 feet in length, and found them entirely satisfactory as well as cheap. To the steam end of the condenser coil is soldered another ⅜ in. union, *j*. A piece of suitably bent 3-16 in. lead pipe is also soldered on the unions, and when these are screwed up make the steam connection from boiler to condenser. The three unions on the steam and siphon pipes are not strictly necessary, but as they are not expensive, will repay their cost in convenience when taking the still apart for cleaning and repairs. The distilled water drips from the end of the condenser coil at *h*.

The siphon feed pipe, *k*, is also made from 3/16 in. lead pipe. This should be so bent as to project an inch or so into the top of condenser, and a piece of rubber tubing one foot in length is then firmly wired on the end, taking care to make the joint air tight. The rubber tube must be supported by a bottle ballasted with shot, or other suitable float, so as to keep the end of tube always in the hottest water at top of condenser and about one inch beneath the surface. If the rubber tubing is of sufficient length, it will prevent the end of siphon becoming uncovered from carelessness. At *j''* is another union connecting the pipe, *k*, with the boiler; this is screwed on an ordinary gas burner cock, *n*, which is soldered to another ⅜ in. brass pipe, *o*, passing down to within one inch of the bottom of the boiler. It may be placed on a line directly back of water gauge, and should be as near the shell as possible to obtain the best circulation of the feed water. To the barrel of the cock, *n*, a 4 in. wire, *m*, is soldered; this moves over an index, *e*, which should be distinctly graduated. This index is made of sheet zinc and tacked to a strip of wood fastened to the wall.

The cold water is supplied to the condenser by the pipe, *d*, and falls into a funnel attached to a pipe leading it to the bottom, where, as it becomes heated, it rises and passes off through an overflow pipe so placed as to always keep the end of the steam pipe covered. The condenser may be permanently placed on a shelf, and so adjusted that the surface of the water in it is at least 18 in. above the usual water level in the boiler. This will insure sufficient fall to operate the siphon. I have found it advisable to maintain the water level about 4 or 5 inches from bottom of boiler.

In the operation of the apparatus steam passes into the condenser and heats the water circulating around its coils as the result of its condensation, this then rises to the top and there passes off through the overflow pipe and the feed pipe to the boiler. If the cold water be allowed to just drop into the condenser, it will keep this part sufficiently cool, and the feed water will be passed back into the boiler heated almost to the boiling point, and there will be very little water remaining to escape through the overflow. A good deal of heat will be thus saved and the action be made continuous, resulting in a great saving of time as well. The feed water is so thoroughly heated that most of the dissolved gases are expelled before passing into the boiler, making it unnecessary to throw away the first part of the water distilling over each time the boiler is refilled. With the index, *e*, set at about V on the scale, just sufficient water passes back into the boiler to maintain a constant line in the gauge. After adjusting the fire and the feed the still is usually allowed to operate for 10 to 12 hours, requiring no attention other than to remove the bottles of distilled water when filled.

The capacity of a still with these dimensions is about one quart of water per hour, with a moderate fire, burning two quarts of gasoline in ten hours. This, with gasoline costing 13 cents per gallon, makes the expense of distilled water about 2½ cents a gallon.

W. M. STINE,
Prof. Chemistry, Ohio University.
Athens, Ohio, June 29, 1891.

NEW FILTER PRESS FOR LABORATORIES.

THE use of the filter press for the separation of precipitates is well known, as are also the services that it is daily rendering. Yet it has been found that in certain cases it furnishes but imperfect results, especially when it is a question of filtering bodies that do not pass through ordinary fabrics. Great difficulties present themselves whenever it is necessary to employ special filters, or when modifications in the temperature or pressure become necessary. It became necessary for laboratory tests to have recourse to costly and complicated apparatus.

The apparatus recently proposed by Mr. Lefranc, which we illustrate herewith, remedies these inconveniences.

The apparatus permits of making all laboratory examinations without installation and without machines. It is made of ebonite, so as to resist acids. It may, however, be made of any other material, such as bronze, cast iron, tin, etc.

Fig. 1 gives a view of the apparatus taken apart.

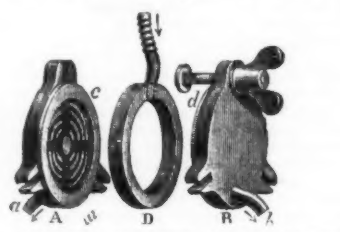


FIG. 1.—PARTS OF THE APPARATUS.

Fig. 2 shows it in operation. The filtering material, fabric or paper, is placed, as in industrial filtering presses, in a box formed of three parts: the ends, A and B, and the ring, D. The ends, A and B, contain grooves that lead the filtered liquid to the tubulures, *a b*. The ring, D, is provided with a tubulure which leads the mixture into the filtering chamber.

The filtering material placed on each side forms the filtering chamber. Tightness is obtained by rubber washers fixed to the plates, A B, against the ring and by three thumb nuts. Above there is a funnel into which is poured the material to be filtered. A height of five or six feet is sufficient for most tests.

We have thus, on the one hand, the filtered liquid, and, on the other, the cake, which is easy to gather or to weigh through the increase in weight of the filter.

It is possible also, with the Gay-Lussac pump in use in all laboratories, to place ourselves in the exact conditions of the industries by employing strong pressures. We may also connect the tubes, *a* and *b*, with a receptacle in which a vacuum is formed, and thus obtain a rapid filtration in which will be combined the action of depression with that of compression.

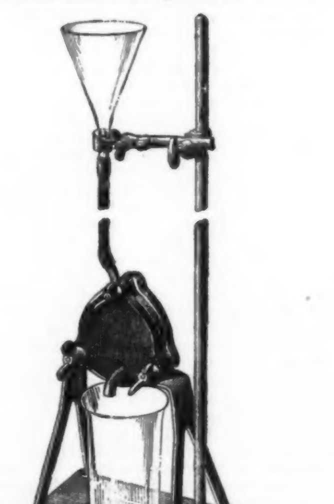


FIG. 2.—NEW LABORATORY FILTERING PRESS.

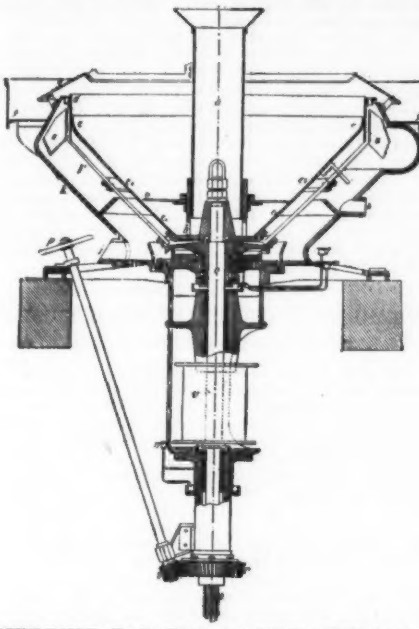
The apparatus is compact, and the filtering surface is of 15½ square inches. It will, therefore, be easy to calculate the rendering of industrial apparatus, and the comparative value of various fabrics, either as regards resistance or filtering value.—*Le Genie Civil.*

A PORTABLE boat has been devised by Colonel Apostoloff of the Russian Army, which may be constructed instantly by making a framework with the lances of the Cossacks and covering with a tarred cloth. Two boats are capable of carrying thirty-six men, with their baggage and arms.

CONTINUOUS CENTRIFUGAL MACHINE FOR THE MANUFACTURE OF SUGAR.

IN all industrial operations inventors are endeavoring to replace manual labor by mechanical apparatus, and when the latter operate in a *continuous* manner, progress reaches nearly its last limit, and there is nothing further to do but study improvements of detail.

The introduction of continuous presses, and especially of diffusion, into sugar works has permitted of



TURBINE FOR THE MANUFACTURE OF SUGAR.

doing away with the onerous labor connected with the old hydraulic presses.

The evaporation of the saccharine juices in triple or multiple acting apparatus has brought about a continuous concentration.

Other parts of the manufacture of sugar are in a way of transformation according to the same general principles. Mr. Horsin-Deon's continuous carbonator and a number of other apparatus are the expression of such a tendency, due to the necessity of diminishing the net cost of the products manufactured.

The separation of the boiled masses has for a long time been an object of research on the part of inventors, but the problem has only very recently been solved, and that by an apparatus that we are about to describe, and which is due to Messrs. Szczeniowski and Piatkowski.

This machine is driven from beneath and revolves from 400 to 500 times per minute.

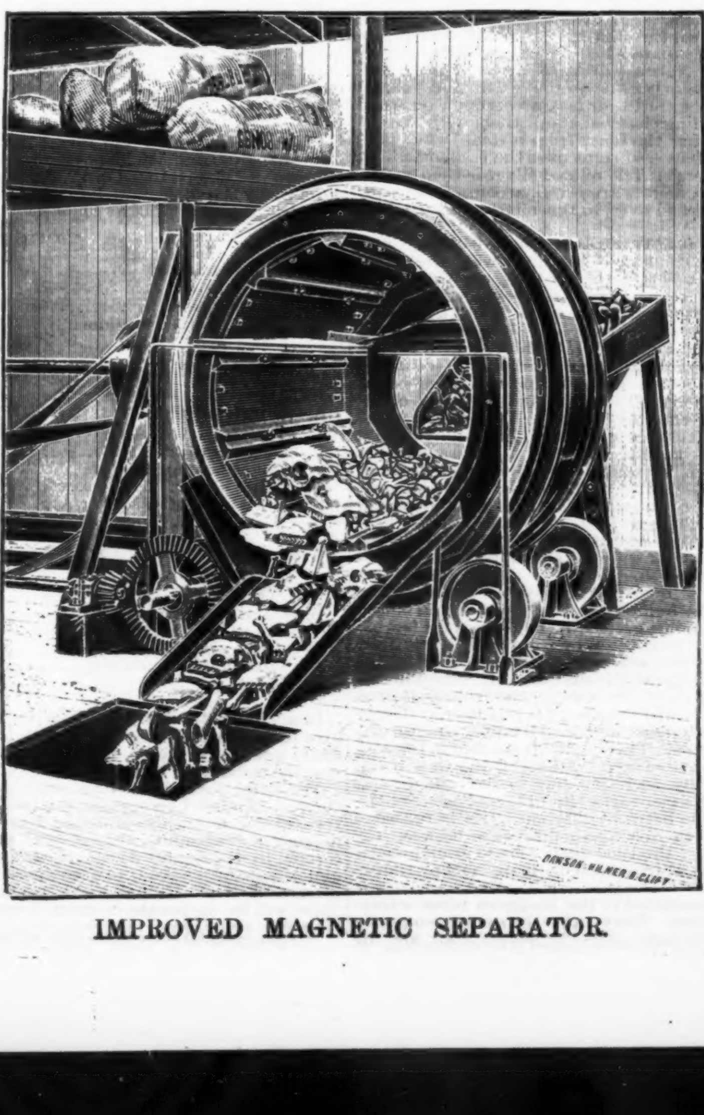
The boiled mass reaches the center of the drum through a vertical pipe, *a*, provided with a funnel; then passing through the apertures, *b*, it is distributed through the space, *c*, to the small extremity of a reversed truncated cone provided with a mechanical filter. The action of centrifugal force tends to make the mass rise toward the wide extremity of the cone. The flow of the mass is regulated at will by the collar, *e*, connected with a nut mounted upon a threaded axis. As the pitch of the screw is minimum, the thickness of the layer that spreads over the filtering cloth may be modified with the greatest facility. This system of regulating the discharge of the boiled mass is extremely sensitive—a matter of great importance. The first drips, the impurest portions, are discharged through the tubulure, *i*. The boiled mass, continuing its ascent above the regulating collar, is freed from less impure sirups, which are discharged though *h*. The drained crystals, after having remounted the entire filtering surface in the form of a truncated cone, meet with a cylindrical surface, *d*. The crystals accumulate at the intersection of the cone and cylinder, forming a slope variable at will by causing the cone to rise or descend within the cylinder. To this effect it suffices to act upon the hand wheel, *p*, which transmits this motion to the gearings, *s* and *r*, and to the nut on the threaded axis, *t*. This variable slope, formed by the drained crystals, brings a variable resistance to the flow of the crystals in course of being drained.

Finally the crystals of sugar escape from the cylinder and are turned into a circular hopper, whence they are removed to be put into bags.

The driving belt passes over the pulley, *v*. The apparatus revolves upon two series of spherical rollers.—*Le Genie Civil.*

IMPROVED MAGNETIC SEPARATOR.

THIS separator is the invention of L. and C. Atkinson and G. W. Elliott, London. It is intended to abstract bolts, nuts, nails, horseshoes, or other iron articles from bones, oil cake or minerals before they are passed into disintegrating machines, the presence of these foreign bodies being detrimental to the machines. The chief difficulties which had to be overcome in designing the machine were the large size and irregular shapes of the materials to be abstracted. The iron also is frequently entangled in the bones, so that merely passing the substance once over or on to a magnet is not found to be sufficient to insure their absolutely certain removal. These points have been satisfactorily overcome by the use of a hollow truncated cone, with ten internal magnets of alternately opposite polarity. The cone revolves on outside runners driven by friction only, which is found ample for the purpose. Into the back ends the bones are fed by a shoot, and, falling to the bottom, are rolled over and over again, so that as they gradually travel forward to the front, in about 10 or 15 complete revolutions, they pass from 100 to 150 times over the magnets. In the upper part of the barrel is a fixed tray into which the iron is delivered and collected. Each magnet in turn as it comes to the bottom is magnetized, and remains so until it reaches the top, where it becomes demagnetized, and the iron is detached, falling into the tray. This process is carried out by a commutating ring on the back of the machine, and the arrangement is such that each coil has one end permanently connected to one pole of the dynamo and the other ends are in turn connected during one-half of a revolution to the other pole. Thus the magnets receive current in parallel. Before cutting a coil out of circuit it is short-circuited through a resistance, and by this means no sparking of any consequence occurs. The machine has proved itself a practical success, and the value of the repeated revolutions over the magnets has been demonstrated by numerous trials. The power required to excite the magnets is about 600 watts for the largest size, capable of dealing with four tons of bones per hour.—*Iron.*



IMPROVED MAGNETIC SEPARATOR.

CHINESE SILVER MINING IN MONGOLIA.*

By Mr. H. F. DAWES, Englewood, New Jersey.

IN China all minerals are, theoretically at least, the property of the Emperor, and the imperial permission must be got from him for the privilege of working them. A direct tax is levied on this privilege, and by simple command the Emperor can close a mine at any time. Occult geomantic influences are a large factor in determining the opening or the arbitrary closing of a mine. The location with reference to points of the compass, graves and natural objects, may be really or professedly considered as indicating that those influences are favorable or unfavorable. The consequence is, of course, that for the authorization and encouragement of any considerable enterprise, friends at court, practical politics, and more or less bribery, are required. As a result, most Chinese mining is illicit, and is carried on in a small way only. Often along a single vein, or over a small section of mining country, a few individuals obtain rights over all the openings, most probably by loaning money to the head men of the operators and holding the mines as security for the debt. In such cases, perhaps, for better security all the ore is reduced in the works established by the creditors, who also handle all silver produced. As the head men are, for the most part, improvident, and the laws and customs for the collection of debts are stringent and peculiar, the "office men" or creditors acquire in time what is practically an ownership of the mines. Workings are often abandoned, and the title to them is passed back to the office men. They are also transferable, with the permission of the office men, and the new operator usually assumes all debts of the previous holder. If he is not known, he must pay the debts on taking possession; but they are a home-staying people for the most part, and unknown men seem to be the exception; so the debt usually runs on for the new man, until transferred again or canceled.

The office men have a large organized force, part at the reduction works and part at the mines. The former part consists of book keepers, store keepers (for the office men supply the head men in great part with tools and materials), and representatives of the office to oversee all details of the reduction of the ore, and last, but by no means least, watchmen, who are present day and night in every section or department. The mine force usually consists of an inspector and watchman for each opening; but when the openings are isolated, or when inspectors or watchmen are increased because the mine is in bonanza, a cook and other functionaries are added. The inspector watches the interests of the office men, sees that the terms of the contract are fulfilled, is on hand when ore is being taken out, reports daily on the appearance of the headings, and keeps the office thoroughly posted upon matters in his district. The contractor or "head man" hires his own miners, watchmen and others, as is the case in the United States.

The following is a translation of a contract between "office men" and "head man:"

"Yang Huei Kuai asks for the old shaft of Ti Tzu Hao; he will carry out all the water and waste rock from the bottom of the shaft; he must clean it all out before beginning to work in ore. The first silver produced to the amount of 500 taels, no matter whether produced from ore or concentrated waste, the office men are to receive two and a half tenths, and the head man seven and a half tenths. Deductions for smelting expenses, tools and other things supplied will be made according to the old rules. All silver produced after the first 500 taels, no matter whether from ore or concentrated waste, the office men are to receive three tenths and the head man seven tenths. Deductions for smelting expenses, tools, and other things supplied will be made according to the old rules. If he stops work the place will be kept for him half a month, and if work is stopped for a longer time it will be given to some one else. He will not be allowed to eat the slags or shares of a new man [*i. e.*, if he forfeits his contract, he cannot approach the new man to whom the place may be given, for a sublease, or make any claim on him for debts contracted while working there]. He will not be allowed to beat a flying hammer [*i. e.*, he must confine his work to the exact locality indicated in the contract and not work elsewhere]; he will not be allowed to keep ore in the shaft, but must send it to the office men as fast as it is produced, and all old and new waste must be sent to the surface and not stored underground. It has been found in the shaft that there is a south drift, a north drift, a small north drift and others, and if they be leased to others, they will all use the same entrance.

"In that case he must not prevent them from using this entrance, nor in any way make trouble with them. If he does, he will then be sent to the magistrate for punishment. This is settled face to face, publicly; and there must be no repentance. Work must be begun on this date. We keep a copy as proof, which will be sent to the head watchman. Written by Sin Chin Chung on the third day of the 10th moon on the 13th year of Kuang Hsu."

In general all contracts are about the same, and provide for miner-like working (though in none of them is timbering mentioned), and for forfeiture if work be suspended for a stated time. In the contract given above, there is a clause releasing any subsequent contractor from all debts contracted by the present one. The absence of this clause in many of the contracts and its presence in this and some others shows that some liability for old debts exists, unless disclaimed; and though such liability is described in some of the contracts to be a "bad custom," the usage still has a recognized legal weight. In Mongolia, north of the Great Wall, there are a number of silver mines, some run in a very small way by squatters, and others more extensively by a sort of company. The country is hilly, more or less rugged, and for the most part devoid of trees. The elevation of the narrow sandy valleys is about 1,000 feet above sea level, and the highest mountains seldom reach 4,000 feet. The climate has two seasons, a wet and a dry. Apart from the almost total absence of snow in winter (a fall of two inches of

* From the Transactions of the American Institute of Mining Engineers.

light feathery snow being considered a severe snow storm), and generally drier atmosphere, it is very like New York and vicinity in ordinary years; the summer temperature often reaching 90° Fahr. in the shade, and during the winter being often at zero.

The miners live in one-story houses, built of stone, cemented with mud. Outside and inside are plastered with mud mixed with straw, to which lime is sometimes added; and the roofs are of thatch, not sewed on, but laid like shingles, beginning at the eaves, and weighted down with poles and stones, which do not always keep it in place against sudden gusts down the gulches. In such houses many live, huddled like sheep; but as long as they get their daily allowance of boiled millet, with some fresh vegetables in summer time, a few ounces of pork meat and fat twice a month, and occasional cakes of wheat flour on feast days, they seem content. A promising outcrop is usually the starting point of the mining work. As soon as the miners have run in on it far enough to be under cover, they have in most cases sunk on it, probably following the ore or the most promising indications. On some veins, which cut right across hills of considerable size, the conditions were good for working by adit; but in no case was advantage taken of this. The shafts are more or less irregular, though some lifts of 60 feet or more are exceptions, following small seams of spar, and in some cases merely the clay selvedge. The timbers are about 3 inches in diameter, and, when not used for shoring up bad ground, are placed across the ends of the shaft about 2 feet apart, and alternately from one end to the other, to serve as ladders. In unproductive ground the shafts are never more than 3 feet long. In open stopes stulls are similarly placed for climbing about on. They serve much better for ladders than the Mexican notched pole, can be traveled over more quickly and with heavier loads. When the vein is more flat, stulls are often set opposite each other, and on the footwall side a stick thrown across them serves as a foot rest. When the vein is flatter yet, steps are cut directly in the foot wall, and timbers are dispensed with entirely, unless needed for bad ground.

Cottonwood, chestnut, willow, oak, pine, and black walnut grow in the region, but not plentifully, and consequently timbers are more or less expensive. Willow seems a favorite and lasts well under ground. Very few large timbers are used. In bad ground, the galleries being for the most part small, the operators seem willing to take their chances of caving; but such shoring as is used when absolutely necessary is of the flimsiest character. The galleries are about 3 feet high and 2 feet wide, just of the size that a man can easily work in, seated on the floor or a small block of wood. As little waste dirt as possible is carried to the surface, abandoned workings being usually packed with it. Even galleries in use are gradually filled, so as to leave only just room enough to get through. No drilling is done or powder used, and all work is done by hammer and chisel. The hammers are of cast iron, weighing 6 to 8 pounds, with handles 6 inches long, and the chisels* are of iron, tipped with steel, sharpened at the forge and tempered. The hammer heads are worn in a short time into cup-shaped depressions, which the miners seem to think reduce the danger of missing the chisel head. They dislike excessively to break their skins so that blood flows.

All the work is single handed. The miner always sits while at work, with his lamp hanging from a twig wedged across the drift in a convenient position. Many of the lamps are beaten out of lead, filled with peanut oil and provided with twisted cotton wicks, which they spin themselves by hand. The waste that has to be taken to the surface is carried up in small shallow baskets on the shoulders of boys; poor ore is always taken up in this way and sorted on the surface near the mouth of the workings, while first-class ore is sacked under ground and taken to the head men in small lots as fast as extracted. Most frequently rich ore must be taken from the vein only in the presence of the inspector. When fifty or more pounds are collected it is carried to the storehouse of the office men, as provided in the contract. Although the work is slow, the wages are low; and the head men, by pawning their clothes and stretching their credit, can go through a great deal of unproductive ground. That which gives them the hardest fight and ultimately stops their work is water. Yet they can handle a good deal of water after their own fashion, when the lift is not too great. The place in the incline a series of boxes constructed of planks, ripped out by hand, and made water-tight with a putty of oil and white clay. These are set in steps about 3 feet apart, and extend from the sump to a point where the water will run out to the surface. On each of these stands a man who, with a closely woven willow basket, holding about four gallons, takes the water from the box on which he stands and empties it into the one above him, and so on until he reaches the surface. Baling goes on rapidly, with intermissions for rest, and when the work is in full swing water enough runs out to fill a 3-in. pipe. This is the hardest work in the mine, and is done by balers, who are deemed inferior to the miners. The stent for each baler is 1,000 baskets per shift. A considerable quantity of water can be handled in this way; but in spite of the low wages it is a serious expense, and unless the deep workings are particularly rich they are often abandoned during the rainy season, to be baled out (if their extent does not forbid such a course) and worked again during the winter months.

The ore collected in the ore house is taken out from time to time for treatment, the times depending on the state of the exchequer, the quantity of ore on hand, and the time of the year, just before new year being the time of the greatest activity in the smelting yard. As a rule small lots of about 100 lb. are treated at a time. All ore is first roasted and then smelted for base bullion, after which the base bullion is refined. The roasting kilns are circular, built of sun-dried brick set up in open checker work, and about 4 feet high and 6 feet in diameter. After erection they are plastered outside and inside with mud mixed with chopped straw, a place being left (to be closed with loose brick) for the removal of the charge. One such furnace lasts through many roastings. All the bricks used are of ordinary clay, rammed into wooden moulds with a heavy stone rammer, and dried in the sun. No straw is mixed with them and no water is used in their making, as the clay when freshly dug is moist enough to stick together under the rammer. The floor of the kilns is slightly depressed in the center, to collect the lead which is often reduced in them when rich ores are roasted. On the floor is spread a layer of charcoal a few inches thick; on this a few inches of ore, and so on until all the ore is charged. The coal is then fired and burns until burnt out.

The fire is a hot one, and the roasting is of necessity imperfectly done, much of the ore melting and some being reduced. The lumps in the roasted charges are broken and picked over, pieces being put aside for re-roasting, and the rest is then smelted in the blast furnace.

The beginning of a blast furnace is a circular depression in the clay floor of the smelting yard, some 18 in. in diameter, and 4 in. in depth, in which sifted wood ashes are pressed to make a shallow cup. Around this a wall is erected of one thickness of mud brick, set on end and plastered together with clay mixed with chopped straw. The furnaces are conical in shape, with throats about 9 in. in diameter, and stand about 3 feet high. One tuyere hole is left near the bottom; and above this hole, on the inside of the furnace, wedge shaped bricks are built into the wall, projecting to the center of the furnace, so that the descending charge or dropping slag may not clog the tuyere. The funnel is plastered inside and out with clay mixed with chopped straw, and when it has been thoroughly dried and heated by a small fire in the hearth, more charcoal is put in, the wind box is set in place and connected with the tuyere, blast is put on and charcoal and roasted ore are added at the discretion of the head man. Bottoms from the cupel furnaces are also added, to furnish lead for collecting the silver; and the unreduced litharge acts also as a flux for the gangue of the ore. Slag flows from a hole near the bottom, which is kept open as long as the blast is on. Lead often runs out, sometimes from cracks that open in the stack; but the yard is clean and nothing is lost, except, of course, that which is vaporized or passes into the slag.

When the lot has been run through, the wind box is taken away, water is freely dashed in the furnace, and, when cool enough, it is torn down, the cake of lead is taken out of the bottom and the debris is carefully sorted over by hand. All the lead is saved, and part of the charge remaining is put aside to be crushed and washed for resmelting. The base bullion, beaten and cleaned from adhering slag and ashes, is then ready for refining in a cupeling furnace.

On the floor of the yard, wood ashes are sifted through a horse hair sieve into a conical heap some 3 ft. in diameter. This is consolidated by pressure of the foot; the top is leveled off and a shallow basin is scooped in it with a wooden hoop; around the base mud bricks are set on their sides in close order, save at a place in front, which is left open to serve as a door. On top of the mound and around the basin are also set mud bricks, but in open order; and across them, so as to cover the basin, are laid mud bricks of full size; just before putting on this cover the base bullion is put in, with paper under it to keep it from bruising the ashes.

Inside the little wall around the base charcoal is then piled, and enough is thrown on to give the whole a rounded dome shape, the top being some 12 in. above the basin cover. The charcoal is ignited at the front near the door, and the whole thing is plastered over with clay mixed with straw, leaving a hole at the top 9 in. in diameter. As the bullion melts, the clay coating becomes baked by the burning charcoal, and as the cupeling continues and the charcoal settles down, the dome supports itself and confines and radiates the heat. If there be not sufficient charcoal originally to carry the refining to the end, more is added from time to time through the hole in the top. The operation is carefully watched through the doorway, and pieces of charcoal and unabsorbed dross are skimmed off with iron tools. Natural draught alone is used, and the silver produced is usually above 0·98 fine. Small lots of base bullion, 10 lb. or less, are refined on wood ash basins, by piling charcoal about them without any covering, and using the blast from a small wind box, the blast being delivered right over the melted bullion through a clay nozzle. The refined silver is then weighed into the office, credits are given, accounts adjusted, and it is then turned over to the melter to turn into currency.

Current silver is of two kinds, about 0·998 fine and about 0·98 fine. The finer is cast into what are called "shoes," of about 50 taels (nearly 67 oz. troy), on which are stamped the name of the makers, the name, together with the external appearance, being their only guaranty. Much of the silver made is not considered good enough for "shoes," so it is allowed with copper for the lower grade and the kind most usually seen. The melter's furnace is dome shaped, and is built of burnt brick, open in front to the room, and having a chimney from the top running outside. It is, in principle, very like a blacksmith's forge, and is blown by a wind box with a single tuyere. The fuel is anthracite from Pekin, of pea size, in which are embedded the small clay cups used for melting. The cakes from the cupeling furnaces are cut up with a cold chisel on the anvil, or, if not too thick, with large iron shears; and when the silver is fine enough, it is weighed out with the proper proportion of granulated copper into a partitioned tray for melting.

The fineness is judged by the eye according to the appearance of the bullion when cut with a cold chisel, long practice having given the melters considerable skill in this particular. When not sufficiently fine, saltpeter, with some sand and salt, are added to the melted silver and the slag is skimmed off. Small ingots about 6 oz. in weight are cast in hemispherical iron moulds, and these when cleaned up, and usually deeply scored on the round side with a cold chisel, to show the interior, are current. The only Chinese coin is the copper cash. Silver is current by weight, the unit being the tael, nominally corresponding to our ounce; but the weight of the tael varies in different parts of the country, and even between different cities in the same provinces; and there is also a difference between the governmental and the local tael. These discrepancies afford the means of livelihood to many money changers or brokers.

One is often reminded of the Mexicans when watching Chinese miners. They show the same keenness in following ore, the same dislike for severe labor, and the same improvidence. The conditions under which they work, on the other hand, are different, as are also the means for accomplishing their ends.

In spite of their boasted civilization, these means seem to us extremely primitive, although long working in the same grooves has given them considerable skill, which partially offsets their obvious disadvantages. The opening of the Tong Shang Colliery, the extension of the railway from Lu Tai to Ta Hu and Tientsin, and the building of the harbor and dry dock at Port Arthur, have drawn attention to China, and have given rise to speculation as to whether these would not prove entering wedges of western civilization, and possibly lead to the extensive working of the Chinese mines after the "foreign fashion." But the Chinese are an intensely conservative people, and at the back of the people is the government, whose very life depends upon keeping things as they are. Hence, their policy is against granting concessions of any kind, and from the present outlook it seems extremely doubtful whether a foreigner can obtain any interest in the mines of any kind. That the country possesses great mineral wealth cannot be doubted, but until the emperor inaugurates a ceremony of pounding the drill, like that which he now performs of turning a furrow every spring with a plow, and thereby dignifies and sanctions mining, its development promises to be desultory and slow.

* These chisels have pyramidal points and resemble the Eisen ohne Helm of the German miners, for which there seems to be no exact English name. Gad involves usually the notion of a wedge, and bit or drill that of a revolving tool which makes a hole; whereas these simply chip or dress the rock. They are from 8 to 18 inches long.

NEW EMULSION FOR PRINTING-OUT PAPER.*

By W. K. BURTON, of Imperial University at Japan.

IN the first place, there are emulsions that need no washing, and that are made by the extremely simple process of pouring one liquid into or mixing one liquid with another. The emulsions are, moreover, ready for use at once, and, being liquid at ordinary temperatures, can be applied to paper or other materials either by floating, as in the common method of sensitizing albumenized paper, or by brushing them over the material that it is wished to sensitize. Farther than this, no gloss is given to the surface of the paper. I think, indeed, that by this process the preparation of sensitized paper—of any kind, so far as surface is concerned—is reduced to the utmost possible simplicity.

I have tried a number of variations in the quantities of chemicals, and have had more or less success with all. In fact, there is great elasticity in the proportions that may be used, and I believe that almost any formula for a printing-out gelatino-chloride emulsion might be taken, and that good results could be got, if one or two considerations were not lost sight of. The first is that the quantity of gelatine must be kept so low that it will not cause a gloss on the paper, or cause the emulsion to set at ordinary temperatures. The second is that the formula must insure a large quantity of insoluble silver salt in suspension. The reason for this is that the coating got by an emulsion that does not gelatinize immediately after coating is much thinner than if it does gelatinize.

To those who have not had much experience in emulsion work, it may be worthy of remark that, within very wide limits, the same quantity of an insoluble silver salt is emulsifiable in a given quantity of water, whether the quantity of gelatine used as a menstruum be great or small. Roughly speaking, the haloids, or, I imagine, the other insoluble or nearly insoluble salts of silver, resulting from the decomposition of one ounce of silver nitrate, can be emulsified in ten ounces of water; but, if that quantity of silver be exceeded, a part will not emulsify, but will be thrown down in the granular form, in which it is useless for sensitizing any surface. The proportions vary, however, with certain conditions, such as alkalinity or acidity of the solutions.

The difference between the failure of a silver haloid to emulsify in a gelatinous solution and the precipitation of it from that solution afterward must not be lost sight of. Thus, if any of the emulsions that I am now writing of be kept for a number of days at a highish temperature—such as that of pretty hot weather—it is likely that a good deal of the insoluble silver salt will be found at the bottom of the vessel holding the emulsion; but this silver salt is not in the granular state, and can be re-emulsified by heating the mixture to about 120° Fahr., and shaking well, the more easily if a little more gelatine be added.

I select three formulæ as follows:

No. 1.

A.—Nitrate of silver	400 grains.
Water	4 ounces.
B.—Gelatine (soft)	80 grains.
Chloride of ammonium	80 "
Citric acid	120 "
Water	8 ounces.

No. 2.

A.—Nitrate of silver	400 grains.
Water	4 ounces.
B.—Gelatine (soft)	80 grains.
Chloride of ammonium	80 "
Citric acid	120 "
Carbonate of soda (dry)	45 "
Water	8 ounces.

No. 3.

A.—Nitrate of silver	400 grains.
Water	4 ounces.
B.—Gelatine (soft)	80 grains.
Chloride of ammonium	80 "
Citric acid	60 "
Carbonate of soda (dry)	80 "
Water	8 ounces.

In my hands the first formula gives an emulsion suitable for preparing paper to be used for printing from dense negatives, the second from medium negatives, and the third from thin negatives.

The third formula is, I am afraid, dreadfully unorthodox. Unless I have made a mistake in my chemistry—which is highly probable—there is just about enough of ammonium chloride and of sodium citrate formed by the double decomposition of the citric acid, and of part of the soda, to decompose the whole of the nitrate of silver. I don't know whether, in this case, there will be carbonate of silver formed; but, if not,

* A communication to the Camera Club, and printed in its journal.

there remains a large excess of carbonate of soda. All I can say is that the formula works all right, and that the paper that results from the use of it keeps very fairly. The paper resulting from either of the other formulas will, I have no doubt, keep as long as any ready sensitized paper. I have already kept some nearly a month, and it is still quite white.

The following is the method of emulsifying. The two solutions are heated to a temperature of 110° to 120° Fahr. The temperature should not be greater than 120°, or there is a great chance that some of the insoluble silver salts produced will be thrown down in the granular form. A is then added slowly to B with much stirring. The emulsion is filtered through a double thickness of cambric, and is then immediately ready for use. If it is wished to keep the emulsion for any length of time, ten per cent. of alcohol, in each ounce of which a few grains of thymol have been dissolved, should be added to the emulsion. It is to be observed, however, that, even with this addition, emulsion by formula No. 3 will not keep for very long.

The best way of coating is certainly by floating, allowing three to four minutes, but the quantity of emulsion needed is considerable. It is possible to get an even coating by brushing with cotton wool in the following way: The paper is laid on a sheet of glass or a clean board, and is thoroughly and evenly damped with the solution by brushing over the surface several times in directions at right angles. It is put on one side for ten minutes or a quarter of an hour to get surface dry, when the operation is repeated. By working in this way it is possible to do with a very small quantity of solution emulsion, and it is possible to use what there is to the last drop, but the quantity used will be found to be more per sheet than in the case of floating. The reason, I imagine, is that it is impossible to get an absolutely even coating by brushing, and that it is therefore necessary to make the coating so thick that there will be sufficient silver where it is at its thinnest. I have never been able to get an even enough coating by brushing only once.

The temperature of the operating room should be not below about 70° Fahr., or else the emulsion should be warmed.

The paper is best dried pretty quickly before a fire, or near a stove, after it has lain face upward for about four or five minutes to get surface dry. In fact, the paper is best treated, in the matter of drying, like paper that has been coated with the solutions for the "hot bath" platinotype process.

It will be found that it is possible to coat about eight sheets of "medium" sized paper (22 × 17, the orthodox photographic size) with the quantity of emulsion given above by brushing, or ten to twelve sheets with a consumption of the like quantity by floating. It will thus be seen that the process is an economical one.

The color in the printing frames should be a rich brown with either of the first two formulas, a deep purple with the third.

The printing is very quick, whichever of the formulas be used, but with No. 3 it is extraordinarily so. Indeed, paper coated with emulsion prepared by this formula is, I think, more sensitive than that by any other printing-out process that I know of. It is so sensitive that it is quite necessary to take extra precautions in working it. It needs at least all the care that platinotype paper needs, although there is, of course, the difference that, in the case of the silver paper, the result of the action of feeble light is seen at once; in the case of the platinotype paper it is not seen till the time of development. I consider it best to do everything in the way of preparation by gas or lamp light.

Toning may be either by gold or platinum. I prefer Clark's platinum process to any other. I add, however, a good dose of salt to the solution, and put the prints into it dry—that is, at least, when using either of the first two formulæ. When using the third, the prints are washed in a weak solution of citric acid before they go to the toning bath, to neutralize the alkalinity.

If a platinotype toning bath that has been used for some time, and that has been repeatedly strengthened with chloro-platinite of potassium, be used, a color is got that some people dignify with the appellation "sepia tint," but I incline to call it a dirty brown.

I find that the emulsion is readily applicable to wood, and I hope to get good results when I have had some panels made of one or other of the beautiful white woods, with a fiber like silk, that are peculiar to this country.

NEW ZINCOGRAPHIC PROCESS.

By August and Louis Lumiere.

The method which we propose may be described as a modification of the albumen process. The facility and the rapidity with which it allows you to produce engraved images of the greatest delicacy and fineness, and the employment as a lined screen of a positive phototype, constitute incontestable advantages. The greater part of the mechanical processes in use require the employment of a reversed negative, which must be both transparent in the shadows and opaque in the lights—conditions somewhat difficult to secure—while the manipulations are of a delicate nature, and can only be carried out satisfactorily by experienced hands.

Our new method does not possess these difficulties of procedure, and, by following exactly the directions which follow, it is possible to obtain at the first attempt images perfect in their nature, and susceptible of furnishing excellent lithographic prints or blocks ready for the typographic press.

The following solution is first of all prepared:

Water	1,000 parts.
Albumen (from fresh eggs)	100 "
Bichromate of ammonia	3 "

(The amount of bichromate should be sufficient to color the solution a light yellow.) This mixture is rapidly stirred, carefully filtered, and, by means of a whirling table, is spread upon a sheet of polished zinc, which has been previously carefully cleaned. As soon as the thin coating of bichromated albumen has been deposited on the zinc in this way, it is necessary to hasten the drying of the compound by lightly heating the metal plate.

The plate is then exposed to the light in a printing frame under a positive, and when the exposure is judged to be sufficient it is removed from the frame and is given a coating of ink, thinned with middle varnish by means of a roller. The color of the surface should then be a dark gray, not black, and without any appearance of the image.

The plate is now immersed in tepid water, and before long the image begins to appear, and the action may be helped by lightly rubbing the surface of the zinc with a tuft of cotton wool.

The image is a negative one, and the shadows of the picture consequently are represented by patches of bare zinc, the albumen on these parts having been protected during the exposure to light, and therefore remaining soluble. It is these portions that have been washed off in the bath of tepid water.

The plate is now thoroughly washed in plenty of water and plunged into a solution of perchloride of iron at 35° B., in which it should remain from ten to fifteen seconds. It is now again washed and dried.

The zinc plate is next heated to about 50° and a roller charged with black ink thinned with middle varnish is passed over it, when it will be found that the ink will adhere to the whole of the surface indiscriminately. By means of another roller, passed several times over the surface of the plate, it is possible to remove the ink from those portions still covered with the insoluble albumen. There only remains now to rub the plate with a soft rag charged with strong ammonia, when the image appears in black on a brilliant background of metallic zinc, for the albumen, although insoluble by light, is soluble in ammonia, and a second development is thus brought about which is the reverse of the first. By the friction, as well as by the action of the ammonia, the ink and albumen are removed, while the ink remains on those portions of the plate which have been partially engraved by the action of the perchloride of iron. It is the latter reaction which forms the basis of our method and which constitutes its novelty. It is very curious to watch this reversal of the image under the influence of the ammonia. Solutions of potash, soda, etc., do not give such clean results, probably because of the saponification which is induced by the presence of the fatty constituents of the ink.

If the plate has to be printed from lithographically, there only remains to prepare in the usual manner. If, on the contrary, we require the image to be in relief, it is necessary to sprinkle over the surface powdered resin and warm it in the usual way before proceeding to the first etching or biting in with acid. In this latter case it is preferable to shorten the immersion of the plate in the perchloride of iron solution in order to avoid roughening too much the surfaces which are ultimately destined to stand up in relief.—*Photo. News.*

YELLOW SCREENS.*

I believe that the principal reason of the apathy of photographers generally to the great advantage obtained by using plates corrected for color lies in the fact that they have been frightened by the "yellow screen bogie." Every photographer who is worthy of the name recognizes that the ordinary processes of photography do not give correct color values, but many refrain from using orthochromatic or isochromatic plates because they have read that they will not work without a screen; and, just to give an idea of how vague are some of the existing notions of the use of screens, I was once asked which was the best place to put the yellow screen in making an enlargement from an isochromatic plate.

Colored compensating screens, far from being a terror, are powerful tools, which, when rightly used, will enable the photographer to render color values in a manner which some artists may sneer at, but will never excel.

The indiscriminate use of a screen is often worse than having no screen at all. If a plate is highly corrected for color, then a yellow screen is not necessary in general landscape work, particularly when working without the sun, such as in glens, interiors, etc., although in bright sunshine the screen is a distinct advantage, as it cuts off a good deal of the white reflected light.

Another stumbling block to the tyro was the abominations that have been sold as compensating screens for photographic purposes; most of them were worse than useless, from being of an unsuitable color, too deep in tint, and of unequal surfaces and thickness. It is a *sine qua non*, as every one knows who has had any experience in this class of work, that glass screens to be used before or behind the lens must be optically worked, so that the two faces, in addition to being perfect planes, must be absolutely parallel to each other.

The question of color is a much more difficult one; a pale orange tint answers excellently for all general purposes, but in my experience a lemon yellow color is the best where a great variety of colors has to be dealt with. Green or greenish yellow is, in my opinion, worst of all.

The best method—in fact, I may say, the only method—for testing screens for color is by means of the spectroscope; thus, a green screen will be found to absorb red and orange, as well as blue and violet, rays in proportion as the green partakes of a blue or yellow character; the more it approaches blue in color, the more red and orange will be absorbed, while if of a yellow green color, more blue rays and less red and orange will be absorbed. Even a greenish tinge in glass has a very sensible effect in absorbing orange rays.

The effects noted above are equally apparent when the screens are tested photographically; and, further, with green screens there is a decided lowering of tone in the green, unless it just happens that the green to be photographed is identical in tints with the compensating screen employed, for if the green to be photographed approached to yellow in tint, and the compensating screen was of a slightly blue green, then the blue of screen would absorb the yellow of subject, and so *vice versa*. For the foregoing reasons I have arrived at the conclusion that, except for special work, a green screen is of no practical use.

A pale orange colored screen—one that increases the exposure about two or three times—will be found valuable for general work. The violet and blue rays are partially absorbed without seriously interfering with the green, orange, and red rays, but when it becomes necessary to cut off the whole of the blue and violet rays, thus requiring a screen of deeper tint, then the orange color is not so suitable, as it absorbs part of the less refrangible rays.

The orange screens are, however, the only really serviceable glass screens at present in the market. There are no pure yellow glass screens manufactured that I am aware of. Doubtless, when photographers wake up to the advantages of using color correct plates, and the demand warrants it, a suitable glass will be manufactured. Unfortunately for photographers, most of the colored glass at present produced is made for decorative purposes.

The most perfect screen, so far as color is concerned, that I have yet seen, is that made in the form of a Waterhouse diaphragm, and supplied by Messrs. B. J. Edwards, of Hackney. The aperture of the stop is covered with a thin lemon yellow medium, which absorbs the violet and blue rays, without appreciably affecting the other rays.

Birt Acres.

—*Br. Jr. of Photo.*

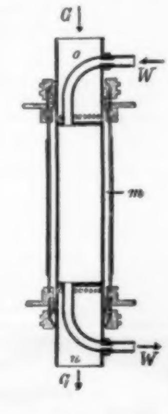
* A communication to the Photographic Society of Great Britain.

THE COMMERCIAL MANUFACTURE OF OZONE.*

By Dr. O. Frölich.

The generation of ozone by electricity, as well as a large number of its interesting reactions, are well known, but the introduction of ozone for commercial purposes has not yet been undertaken, on account of the lack of suitable apparatus for generating it in large quantities. The best method of generating ozone electrically, as is well known, is by means of the silent discharge, and as early as 1857 W. Von Siemens designed his well-known ozone tube, which is still in use in laboratories.

The same idea has been embodied in the apparatus recently designed at the works of Siemens & Halske, of Berlin, for commercial purposes, and its construction is shown in the accompanying engraving. As



will be seen, it consists of an inner metal tube which is surrounded by an outer one forming the dielectric tube. The top and the bottom of the metal tube are closed, and the space between these two covers is filled with cooling water kept in circulation by tubes, W and W, reading from the top and bottom. Above the top and below the lower covers there are rows of holes through which the gas to be treated, G, is drawn from the upper space, *o*, into the space, *m*, between the dielectric cylinder wall and the inner metal tube. From there it passes to the lower end, *u*, and out. The dielectric cylinder is made of hard rubber or celluloid, and leather rings serve to connect the parts.

The apparatus is so arranged that the cooling water passes through all the tubes, and so that a tube in case of a rupture can be easily replaced.

The author has employed continuous currents, interrupted by a special rotating commutator at a rate of 600 per second. By this means far more ozone is generated than with an alternating current machine and induction coil having only 50 to 100 reversals per second. However, when the number of ozone tubes is increased, this relationship is reversed and the alternating current exceeds in efficiency the continuous interrupted current. Further investigation seems to show that the generation of ozone is largely dependent upon the nature of the alternating current, and that the steeper the curve the more efficient it is. The generation also depends upon the mean E. M. F. in the tube; thus, up to 4,000 volts, using a glass tube, no ozone is generated. With increase of potential, other things being equal, the generation increases rapidly until finally the tube bursts, so that care must be taken not to exceed a certain limit. It was also determined that transformers with open magnetic cores, as in the ordinary Ruhmkorff coil, are more efficient than those with closed magnetic cores. Experiments have shown that with 2 horse power, 2·4 milligrammes of ozone per second can be produced.

Among the many applications to which ozone lends itself, the author mentions particularly the disinfecting and sterilizing of water, there being good reason for assuming that the worst natural water can be made potable by ozonizing. He also refers to its application in bleaching processes and the curing of wines, and, generally, for disinfecting purposes, its action on all bacteria and small insect life being very destructive.

THE INFLUENCE OF HEAT ON THE STRENGTH OF IRON.

Professor Martens, of Berlin, has published in the *Mittheilungen aus den Kœniglichen technischen Versuchanstalten zu Berlin* a report of some experiments on the strength of steel at various temperatures between 20° Cent. and 600° Cent. The material used consisted of mild steel, having a tensile strength of 23 tons, 27 tons, and 30 tons per square inch. The bars from which the test pieces were cut were 1·5 in. in diameter and were thoroughly annealed. A number of bars of

* Abstract of a paper read before the Elektrotechnische Verein of Berlin.

the same quality of metal were all tested in the usual way, both after annealing, and as received from the makers, so as to form a standard of comparison for the other bars. The temperature of the bars, by placing in a bath and testing them there. For the low temperature tests the bath was filled with a freezing mixture and for the high temperature tests with paraffin, up to 200° Cent., beyond which alloys of lead and tin were used. The contents of the bath were warmed by gas jets and stirred during the course of the experiments. The elongations of the bar up to the yield point were taken on a length of 8·1 in. by means of a mirror apparatus, the diameter of the tested portion being 0·79 in., and autographic diagrams were also taken of each specimen. The results of the experiments showed that the elastic limit of the material became lower as the temperature rose, though the falling off was not very serious up to 200° Cent., but beyond that point it lowers somewhat rapidly, and finally seems to disappear. The maximum stress decreases from 20° Cent. up to 50° Cent., but afterward rapidly rises to a maximum somewhere between 200° and 250° Cent. Taking the strength of the specimen at 20° Cent. as the maximum stress for the 23-ton steel is 1·34 greater, and the maximum breaking stress is 1·63. For the 27-ton steel the figures are 1·27 and 1·45, and for the 30-ton steel 1·25 and 1·30. The contraction of area for all the specimens was least at about 300° Cent.

THE AFRICAN DIAMOND MINES.

IN a recent letter to the London *Daily Graphic*, Randolph Churchill writes as follows:

Mr. Gardner Williams, the eminent mining engineer who occupies the important post of general manager to the De Beers Company, was kind enough to accompany me all over the mines, and to explain in detail the method of operation. The De Beers and the Kimberley mines are probably the two biggest holes which greedy man has ever dug into the earth, the area of the former at the surface being thirteen acres, with a depth of 450 feet, and the area and the depth of the latter being even greater. These mines are no longer worked from the surface, but from shafts sunk at some distance from the original holes, and penetrating to the blue ground by transverse drivings at depths varying from 500 to 1,200 feet.

The blue ground, when extracted, is carried in small iron trucks to the floors. "These are made by removing the bush and grass from a fairly level piece of ground; the land is then rolled and made as hard and as smooth as possible. These floors are about 600 acres in extent. They are covered to the depth of about a foot with blue ground, which for a time remains on them without much manipulation. The heat of the sun and moisture soon have a wonderful effect upon it. Large pieces which were as hard as ordinary sandstone when taken from the mine soon commence to crumble. At this stage of the work the winnowing of the diamonds assumes more the nature of farming than of mining; the ground is continually harrowed to assist pulverization by exposing the larger pieces to the action of the sun and rain. The blue ground from Kimberley mine becomes quite well pulverized in three months, while that from De Beers requires double that time. The longer the ground remains exposed, the better it is for washing."*

The process of exposure being completed, the blue ground is then carried to very large, elaborate, and costly washing machines, in which, by means of the action of running water, the diamonds are separated from the ordinary earth. It may be mentioned that in this process 100 loads of blue ground are concentrated into one load of diamondiferous stuff. Another machine called the pulsator then separates this latter stuff, which appears to be a mass of blue and dark colored pebbles of all shapes, into four different sizes, which then pass on to the assorters. "The assorting is done on tables, first while wet by white men, and then dry by natives."† The assorters work with a kind of trowel, and their accuracy in detecting and separating the diamond from the eight different kinds of mineral formations which reach them is almost unerring. "The diamond occurs in all shades of color, from deep yellow to blue white, from deep brown to light brown, and in a great variety of colors, green, blue, pink, brown, yellow, orange, pure white, and opaque."* The most valuable are the pure white and the deep orange. "The stones vary in size from that of a pin's head upward; the largest diamond yet found weighed 428½ carats. It was cut and exhibited at the Paris exhibition, and after cutting weighed 228½ carats.

CLEANING AND SORTING.

"After assorting, the diamonds are sent daily to the general office under an armed escort and delivered to the valuators in charge of the diamond department. The first operation is to clean the diamonds of any extraneous matter by boiling them in a mixture of nitric and sulphuric acids. When cleaned they are carefully assorted again in respect of size, color, and purity."† The room in the De Beers office where they are then displayed offers a most striking sight. It is lighted by large windows, underneath which runs a broad counter covered with white sheets of paper, on which are laid out innumerable glistening heaps of precious stones of indescribable variety. In this room are concentrated some 60,000 carats, the daily production of the consolidated mine being about 5,500 carats. "When the diamonds have been valued they are sold in parcels to local buyers, who represent the leading diamond merchants of Europe. The size of a parcel varies from a few thousand to tens of thousands of carats; in one instance, two years ago, nearly a quarter of a million of carats were sold in one lot to one buyer.‡

The company sustain a considerable loss annually, estimated now at from 10 to 15 per cent., from diamonds being stolen from the mines. To check this loss extraordinary precautions have been resorted to. The natives are engaged for a period of three months, during which time they are confined in a compound surrounded by a high wall. On returning from their day's work they have to strip off all their clothes, which they hang on pegs in a shed. Stark naked they then proceed to the searching room, where their mouths, their hair, their toes, their armpits, and every portion of their body are subjected to an elaborate examination. White men would never submit to such a process, but the native sustains the indignity with cheerful equanimity, considering only the high wages which he earns. After passing through the searching room they pass, still in a state of nudity, to their apartments in the compound, where they find blankets in which to wrap themselves for the night. During the evening the clothes which they have left behind them are carefully and minutely searched, and are restored to their owners in the morning. The precautions which are taken a few days before the natives leave the compound, their engagement being terminated, to recover diamonds which they may have swallowed, are more easily imagined than described.

ASSORTING THE DIAMONDS.

"I. D. B."

In addition to these arrangements, a law of exceptional rigor punishes illicit diamond buying, known in the slang of South Africa as I. D. B.ism. Under this statute the ordinary presumption of law in favor of the accused disappears, and an accused person has to prove his innocence in the clearest manner instead of the accuser having to prove his guilt. Sentences are constantly passed on persons convicted of this offense ranging from five to fifteen years. It must be admitted that this tremendous law is in thorough conformity with South African sentiment, which elevates I.D.B.-ism almost to the level, if not above the level, of actual homicide. If a man walking in the streets or in the precincts of Kimberley were to find a diamond and were not immediately to take it to the registrar, restore it to him, and to have the fact of its restoration registered, he would be liable to a punishment of fifteen years' penal servitude. In order to prevent illicit traffic the quantities of diamonds produced by the mines are reported to the detective department both by the producers and the exporters. All diamonds except those which pass through illicit channels are sent to England by registered post, the weekly shipments averaging from 40,000 to 50,000 carats.

The greatest outlet for the stolen diamonds is through the Transvaal to Natal, where they are shipped by respectable merchants, who turn a deaf ear to any information from the diamond fields to the effect that they are aiding the sale of stolen property.* The most ingenious ruses are resorted to by the illicit dealers for conveying the stolen diamonds out of Kimberley. They are considerably assisted by the fact that the boundaries of the Transvaal and of the Free State approach within a few miles of Kimberley, and once across the border they are comparatively safe. Recently, so I was informed, a notorious diamond thief was seen leaving Kimberley on horse back for the Transvaal. Convinced of his iniquitous designs, he was seized by the police on the border and thoroughly searched. Nothing was found on him, and he was perforce allowed to proceed. No sooner was he well across the border than he, under the eyes of the detective, deliberately shot and cut open his horse, extracting from its intestines a large parcel of diamonds which previous to the journey had been administered to the unfortunate animal in the form of a ball.

A MODEL ORGANIZATION.

The De Beers directors manage their immense concern out here with great liberality. A model village, called Kenilworth, within the precincts of the mines, affords most comfortable and healthy accommodation for several of the European employes. Gardens are attached to cottages, and the planting of eucalyptus, cypress, pine, and oak, as well as a variety of fruit trees, has been carried to a considerable extent. A very excellent club house has also been built, which includes, besides the messroom and kitchen, a reading room, where many of the monthly papers and magazines are kept, together with six hundred volumes from the Kimberley Public Library. There is also a billiard room, with two very good tables given by two of the directors. A large recreation ground is in the course of construction. Within the compound where the native laborers are confined is a store where they can procure cheaply all the necessaries of life. Wood and water are supplied free of charge, and a large swimming bath is also provided, but I did not learn if the natives made much use of it. All sick natives are taken care of in a hospital connected with the compound, where medical attendance, nurses, and food are supplied gratuitously by the company. I should not omit to mention that the entire mine above and underground is lighted by electricity. There are ten circuits of electric lamps for De Beers and Kimberley mines. They consist of fifty-two arc lamps of 1,000 candle power each and 691 glow lamps of sixteen and sixty-four candle power each, or a total illuminating power of 63,696 candles. There are, moreover, thirty telephones connecting the different centers of work together, and over eighty electric bells are used for signaling in shafts and on haulages.

Such is this marvelous mine, the like of which I doubt whether the world can show. When one considers the enormous capital invested, the elaborate and costly plant, the number of human beings employed, and the object of this unparalleled concentration of effort, curious reflections occur. In all other mining distinctly profitable objects are sought and purposes are carried out beneficial generally to mankind. This remark would apply to gold mines, to coal mines, to tin, copper, and lead mines, but at the De Beers mine all the wonderful arrangements I have described above are put in force in order to extract from the depths of the ground, solely for the wealthy classes, a tiny crystal to be used for the gratification of female vanity in imitation of a lust for personal adornment essentially barbaric if not altogether savage. Some mitigation of cynical criticism might be urged if the diamonds only adorned the beautiful, the virtuous, and the young, but this, unhappily, is far from being the case, and a review of the South African diamond mines brings me coldly to the conclusion that, whatever may be the origin of man, woman is descended from an ape.

TAXIDERMY AND ZOOLOGICAL COLLECTING.

UNDER this title an interesting and valuable volume of some 350 pages, by William T. Hornaday, has recently been published by Charles Scribner's Sons, New York. Chapters are also given by W. J. Holland on collecting and preserving of insects. Mr. Hornaday is widely known as an experienced taxidermist. The work is a complete handbook to the art of taxidermy. It is profusely illustrated and contains probably the best collection of directions for the preservation and mounting of zoological specimens, from the largest down to the smallest, that has yet been given to the public. By permission of the publishers we give a few illustrations, of which the titles are sufficiently descriptive.

One of the important substances used in the finishing of specimens is papier maché, and how to make it is told in the book as follows:

The following are the ingredients necessary to make a lump of papier maché a little larger than an ordinary base ball, and weighing 17 ounces.

FINE PAPIER MACHÉ.

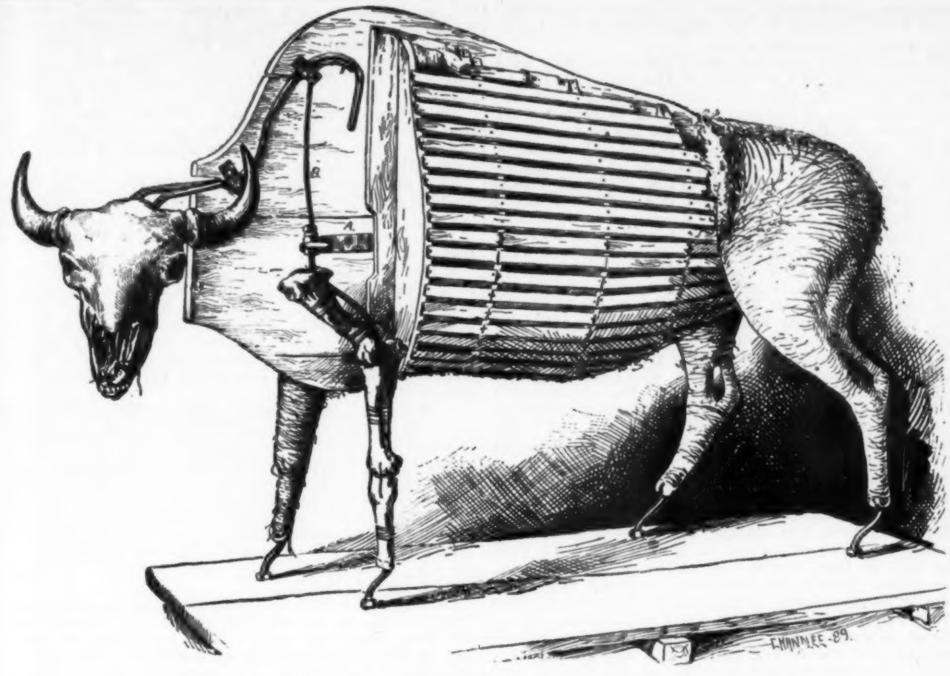
Wet paper pulp	dry paper, 1 ounce; water, 3 ounces	4 ounces (avoirdupois).
Dry plaster Paris	....	8 ounces "
Hot glue	....	⅛ gill, or 4½ tablespoonfuls.

While the paper pulp is being prepared, melt some best Irish glue in the glue pot, and make it of the same thickness and general consistency as that used by cabinet makers. Measure the different ingredients to be used, until the result teaches you what good papier maché is like, and after that you can be guided by your judgment as you proceed. On taking the paper pulp from the water, give it a gentle squeeze, but by no means squeeze it as dry as you can. Now put it in a bowl, put over it about three tablespoonfuls of your hot glue, and stir the mass up into a soft and very sticky paste. Next add your plaster Paris, and mix it thoroughly. By the time you have used about three

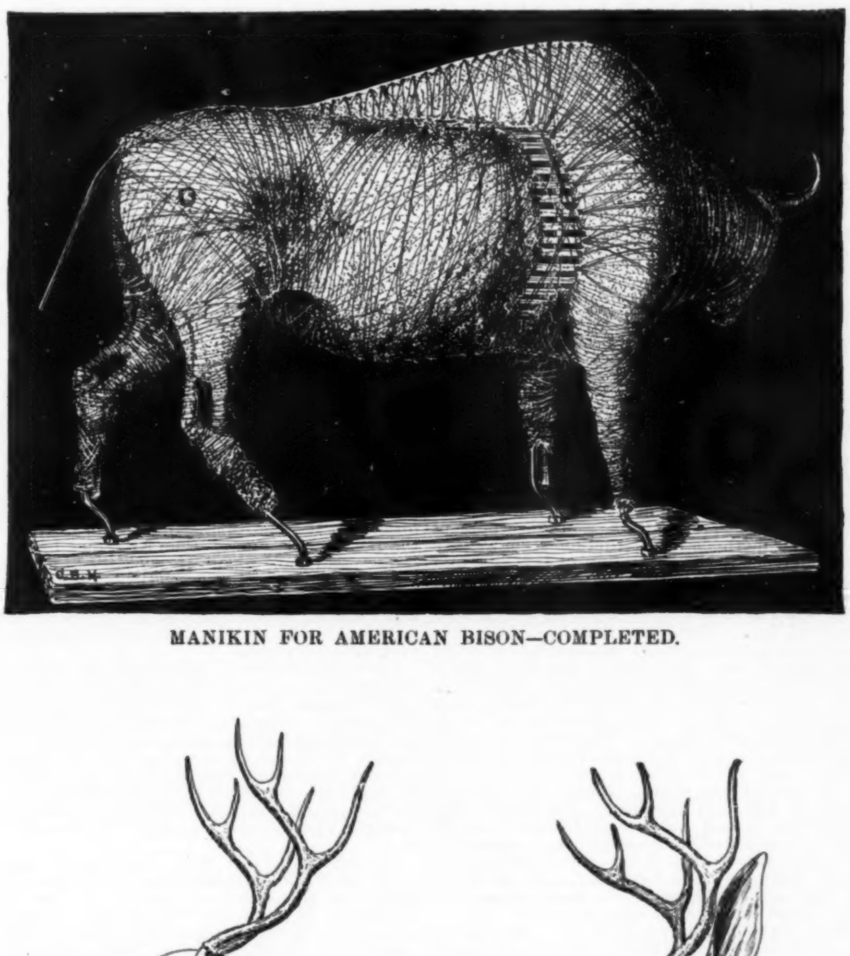
* Report, 1890, General Manager, De Beers. † Ibid.

* Ibid. † Ibid. ‡ Ibid.

* Ibid.



MANIKIN FOR MALE AMERICAN BISON—HALF COMPLETED.



MANIKIN FOR AMERICAN BISON—COMPLETED.

INTERNAL MECHANISM OF A DEER HEAD

COMPLETE MANIKIN FOR DEER HEAD, WITHOUT CLAY COVERING.

ounces of the plaster, the mass is so dry and thick you can hardly work it. Now add the remainder of your glue, work it up again until it becomes sticky once more, then add the remainder of your plaster. Squeeze it vigorously through your fingers to thoroughly mix the mass, and work it until it is free from lumps, is finely kneaded, and is sticky enough to stick fast to the surface of a planed board when you rub a bit on it by firm pressure of the finger. If it is too dry to stick fast, add a few drops of either glue or water, it makes little difference which, and work it up again. When the paper pulp is poor, and the maché is inclined to be lumpy, lay the mass upon a smooth board, take a hammer and pound it hard to grind it up fine.

If the papier maché is not sticky enough to stick fast to whatever a bit of it is rubbed upon, it is a failure, and requires more glue. In using it the mass should be kept in a lump, and used as soon as possible after it is made. Keep the surface of the lump moist by means of a wet cloth laid over it, for if you do not, the surface will dry rapidly. If you wish to keep it overnight, or longer, wrap it up in several thicknesses of wet cotton cloth, and put it under an inverted bowl. If it should by accident or delay become a trifle too stiff to work well, add a few drops of water to the mass, pound it with the hammer and work it over again. If you wish to keep a lump for a week, to use daily, add a few drops of glycerine when you make it, so that it will dry more slowly.

The papier maché made when the above formula was prepared had the following qualities: When tested by rubbing between the thumb and finger, it was sticky and covered the thumb with a thin coating. (Had it left the thumb clean, it would have been because it contained too much water.) When rubbed upon a pane of glass, it stuck tightly and dried hard in three hours without cracking, and could only be removed with a knife. When spread in a layer, as thin as writing paper, it dried in half an hour. A mass actually used dried hard enough to coat with wax in eighteen hours, and, without cracking, became as hard as wood; yet a similar quantity wrapped in a wet cloth and placed under an inverted bowl kept soft and fit for use for an entire week.

Such are the qualities of first class papier maché, and the manner of producing them all. I have dwelt at great length on this material because it is such an important and indispensable factor in general taxidermic work. It will pay any taxidermist to become an expert in making it and using it, and a little later, when we get to modeling intricate mouth parts, and making all sorts of restorations and repairs, we shall see what a valuable servant is papier maché.

SUBSIDENCE OF THE ATLANTIC COAST.

IN recent years quite a revolution of opinion has occurred among geologists, says *Stone*, and the old theory of continental uprisings and mountain formation being of igneous and cataclysmic origin is giving way to a more rational one that the changes are due to very slow vibrations of the earth's crust, always in operation, and not much different in ancient geologic time than in the present, and where water, rather than fire, is the principal agent. It has been shown that, were the earth of solid steel, the mighty forces of gravitation, and perhaps magnetism, would treat it much as if it were a mobile liquid. Steel, under sufficient pressure, flows precisely as water does. Hence it is not necessary to assume a gaseous or liquid molten condition to account for the elevation and depression of continents. Almost all of the crystalline rocks, once believed to be of igneous origin, are crystalline deposits of acid and alkaline bases held in solution by water, deposited through long ages, in sea bottoms, and very gradually, through forces whose origin is not clearly understood, upheaved and folded: and by erosion, where the crystals are of resisting nature, left exposed as mountain masses, to be again, through solution and erosion, carried back to the ocean bottom, to go through the long evolution again. That heat is among the agents, there can be no doubt, but volcanic temperature would easily be produced by strains in the earth's crust, under the prodigious pressure of entire continents, but such temperature would be subsidiary, and not primary. So the probability of slow evolution with water as the agent of most of the changes is now becoming generally accepted.

A very interesting contribution on the slow process of continental subsidence, which of course creates equivalent elevation of the sea bottoms, was published in the *Washington Star*, on the subsidence of the Atlantic coast, which we reprint as follows:

"The Atlantic coast line from Cape Cod to Cape Hatteras, which at this season of the year is infringed with merry bathers, is retreating with steady and alarming rapidity before the waves of the ocean," said a geologist. "Each average year the waters advance one rod inland where no bluffs afford a temporary and receding barrier. Property owners at summer resorts all along the shore view with dread the encroachment of the sea, trying their best to oppose its progress with breakwaters and other feeble expedients. Nevertheless, the eating away of the shore still proceeds, inexorable Neptune devouring it inch by inch. Ocean Avenue, at Long Branch, only a few years ago was a broad road; now is a narrow one, comparatively, its width decreasing annually. At other points the beaches of a generation back are hundreds of yards out at sea. The seaside cottage, with a broad lawn before it, has an expectation of a life of a decade or so, perhaps, but it must go. Not long since a huge hotel at a popular summer city had to be dragged by a team of locomotives a considerable distance to escape the waters which were undermining it.

"Along the gulf coast from Mobile Bay to the mouth of the Mississippi the same direful process is going on. Villas and orange groves on the shore are swept away and inundated by the advancing waves. Thirty-four years ago Last Island, a health and pleasure resort of New Orleans, was swallowed up by the storm waters, with most of its transient population, and only a tide-washed bank remains to mark its sight. More than once since then villages and settlements on the margin of the Gulf and upon the Delta Islands of the Mississippi have been wiped from the face of the land. All these occurrences tell the same story of encroachment by the ocean upon the continent.

"Comparison of maps shows that the Atlantic coast,

from Barnegat Inlet, twelve miles southward, known as Long Beach, has in thirty-two years retreated 545 feet—more than one-tenth of a mile. Surveys of Cape May County demonstrate that within the last century the shore along it has receded three-quarters of a mile. On the Carolina coast the advance of the sea upon the rice plantations has been going on steadily for three generations. 'The sea is devouring land,' says Lafcadio Hearn. 'Many and many a mile of ground has yielded to the tireless charging of ocean's cavalry. Far out you see with a good glass the porpoises at play where of old the sugar cane shook out its million bannerets, and shark fins are now seen in deep water above a site where pigeons used to coo.'

"One curious feature of these alterations of the coast line by the encroachment of the seas is found in the exposure by the advancing waters of ancient meadows and forests long buried. In this manner have been disclosed to view old cedar swamps, and thus a singular industry—actual mining for timber—has been created.

"At several points in eastern New Jersey enormous quantities of white cedar and magnolia logs, sound and fit for use, are found submerged in what have now become salt marshes. Many of the trees thus exhumed were forest giants. In the Great Cedar Swamp, on the creek of the same name, the trunks reach a diameter of seven feet.

"The cause of all this is that the Atlantic and Gulf coasts are actually sinking, and the rate at which they are going down is estimated by the official geologist of New Jersey at two feet per century. Now, the general seaward slope of the edge of the continent is about six feet to the mile, so that the sinking of each 100 years gives a third of a mile of lowland to the ocean. This would seem to be rather less than the rate of encroachment indicated by comparing of maps made at successive periods. Modern geologic science has ascertained that the entire crust of the earth is in a condition of such sensitive equilibrium that the taking of weight from one part of it to another brings about elevation of the portion from whence the weight is removed and produces a corresponding depression of the portion where it is added. The rivers which empty into the Atlantic from Cape Cod to Cape Hatteras, and along the shore of the Gulf, carry out into the ocean each year billions of tons of material, which is thus deposited outside the ocean's edge. The weight thus transferred causes a steadily progressive depression of the coast line.

"If all the water in the Atlantic Ocean were dried up you would perhaps be surprised to observe that the eastern edge of the great land mass which we call the North American continent is not the present beach line at all. You would see that the continent itself extends far out into the ocean, a distance varying from fifty to one hundred and fifty miles. Once upon a time this terrace was all above the water; the east shore of the continent had a very different shape, there was a deep sea close to coast, and the localities where now are situated New York, Philadelphia and Boston were far inland. Gradually, owing to the causes I have mentioned, this great terrace has sunk, so that ships are sailing over what a few thousands of years ago was dry land. So short a time, from the geological point of view, has been required to effect this change that the beds of the Hudson, the Potomac and other great streams are still deep channels cut out of the terrace, a sufficient period not having elapsed for filling them up with detritus.

"The process by which this was accomplished is steadily and progressively going on. Each year the Atlantic shore line—and the same is true of the Gulf coast—is farther westward by an average distance of a rod. For each century there is a loss of one third of a mile to the edge of the continent. How long is it going to be at this rate before the eastern costal plain of the United States is submerged beneath the ocean, together with all its populous cities and fertile fields? These plains, originally fashioned by the sea, the ocean is claiming for its own. Its octopus arms are seizing them in their embrace, and day by day, month by month, year by year, generation by generation, the monster is creeping further inland. Its power is too great for puny man to oppose successfully; he can only slowly retreat before the invasion."

SIBLEY COLLEGE LECTURES.—1890-91.

BY THE CORNELL UNIVERSITY NON-RESIDENT LECTURERS IN MECHANICAL ENGINEERING.

ART FROM A SCHOOLMASTER'S POINT OF VIEW.*

IT is difficult, if not impossible, to measure with much approach to exactness the tendencies and spirit of the age in which one lives. The significance, and even the reality, of the Renaissance of interest in art in the midst of which we believe we live, only those who come after us may accurately measure. How much we really care for art and all that art implies—this will appear when the story of our times comes to be written by and by. But as far as we are permitted to judge, a vast increase of interest in all that art stands for, and implies, in human effort and attainment does characterize the present age as it has characterized no other among English-speaking peoples. I say English-speaking peoples, because while the newly awakened interest in art in its relation to industry and to industrial education is perhaps as pronounced in France, or Germany, or Russia, or Italy, as in England or America, the awakening to a recognition of the claims of art itself is much more noticeable in the case of these last, for the reason that several causes, the nature and extent of which we are dimly conscious of, have operated in the past, as their influence is felt in the present, to hinder and discourage the development of the artistic sense in the race to which we belong.

How deep-seated these causes are, whether, as some would have us believe, Mr. Taine for example, they are questions of race, so that incapacity for art is to be accepted as something inherent in the English nature, this is something which I shall not attempt to discuss at any length in this place.

Even if the grounds for such sweeping discouragement were more apparent than they are, as far as England is concerned, it is evident that the race has undergone very substantial modifications since it was transplanted to America, and conclusions that might be just with reference to one country would not necessarily apply to the other at all.

But whether we trace our artistic shortcomings back to race peculiarities or only to the unfortunate repression for which the ultra-protestantism that has found expression in the multiplication of sects: Puritan, Quaker, Methodist, Baptist and the rest; a spirit that has undoubtedly always been hostile to the arts, by reason of the supreme importance which it has attached to that higher appeal to the spiritual side of our nature, which must be made, if at all, by methods which transcend all those outward sensuous things with which art has to do; to whatever source we trace them, the shortcomings certainly exist, and mark us as probably the least artistic among the races of men.

Now I think there is among us a real awakening to a consciousness of this, and to a sense of the truth that, although these shortcomings are associated with qualities which we have most reason to regard as noble, they are not exactly part and parcel of them; to a sense of the fact that while we may owe our want of taste in part, at least, to the exercise of a zeal for the things which make for the highest good, the want of taste is itself not only not good, but is not by any means a necessary accompaniment of this high and noble purpose.

Two phases of this awakening possess especial interest for the teacher, and claim as it seems to me about equal shares in current educational discussion.

These are, first, the claims of the æsthetic sense to recognition in all education as among the most precious, and so best worth cultivating, of our powers, these claims resting on the very broadest and least special grounds; those indeed on which all pleas for culture are based: and second the significance in industrial education of this emphasis of the artistic as being the very center and core of the whole matter.

I am ready and willing to admit at the outset that this last is the lower ground, but it is interesting, and may not be unprofitable, to notice that it is on this side that the greatest interest seems to have been awakened thus far, and by far the most tangible results obtained. It is, moreover, the one on which I feel most competent to speak, and in which my own experience has been chiefly gained, so that this must be my apology, if any is needed, for such narrowing of my subject as may appear as I go on.

I have to speak, then, mainly of art education as a part of industrial education, nay, as the very pith and marrow of that education, the most central and life-giving influence that can inspire it.

As I understand it, the keynote of the new cry in education is this, that as the noblest thing in life is to do something well, so educational methods should be such, at least in part, as to familiarize the pupil with creative energy and productive processes; should bring something of the atmosphere of active life into the school room, instead of regarding this last as something apart from the world of active effort; a kind of cloister indeed, more of a refuge from the world than a preparation for it. This older idea has long dominated educational purpose, it is true, but how truly also is it a survival from the darkest days of history. The Greek idea of education was development; to make healthy "all-round" men; men who could think and speak and act; men who could dance and sing and play and fight; men who could be depended upon in emergencies of all kinds, but were expected to face one emergency or fill one sphere about as well as another.

Are we doing anything better than working out in new ways this old idea?

The more practical Romans cherished in education a more restricted ideal. Their aim was to train leaders of men; commanders, organizers, and governors of states, and their methods of instruction seem to have had direct reference to the promotion of this aim, and so to have been practical in the strictest sense.

And in one sense the methods of the cloister which have come down to us as a legacy from the middle ages were practical, too, in the sense, that is, of being devised and fitted to train men for contemplation or for purely clerical service. They did fit men to be thinkers and preachers and spiritual advisers in times when thought and action, when preaching and practice, were divided and even at war as they cannot be said to be to-day. But monastic ideas in education are only lingering survivals now of times and things that have passed away, and the school has become, or we are beginning to demand that it shall become, the conservatory of skill as well as of knowledge, and that it shall train men for the actual business of living in a world where action is expected to be thoughtful; where precept is of small account if it is not embodied in example; where every day is a holy day, and all duties sacred; where all faithful service is consecration, and where the highest and holiest office is to be of use.

This, then, is the modern practical spirit as I understand it. Is it, as some very worthy people are afraid, a dangerous spirit? Does it imply a lowering of aims? A letting down of standards? The exaltation of that bugbear, materialism? Let us see.

The industrial idea, if followed up, leads straight to the science idea and the art idea, these two being found to be fundamental to all real accomplishment, so that from the manual training school of a grade hardly higher than the grammar school to the technical college, two or three times as much time is devoted to scientific studies and drawing as is the case with the school in which the literary standard is still the only one respected. Is this a mistake or an advantage?

To ask whether science is demoralizing, is to ask whether the truth can be trusted, and if the pursuit of art tends to materialism, what spiritualizing influence has the world ever known?

Art is almost a synonym for the ideal and the pursuit of one. Does it not imply devotion to the other? When it does not, it is the method, and not the aim, that is at fault.

Recognition of this truth, that industrial improvement means the promotion of culture in science and art, is the found-tion of the work undertaken by the English government forty years ago, which has furnished more or less of a precedent for what has been done in America in obedience to a similar impulse. That the English system of schools organized and administered by the science and art department, as it is called, is a comparative failure as far as any high attainment or accomplishment is concerned, is admitted, but the failure is only comparative after all; it is inseparable from conditions and methods which I have no time to examine here, but which are not difficult to explain, and it should not blind us to the fact that the English system stands for a well meant and intelligent effort, and has accomplished a great deal of good.

Its central purpose is not different after all from that which forms a conspicuous part of the educational effort of other countries whose example is worth perhaps still more to us.

The emphasis which is laid on the claims of industrial and technical education is not less pronounced, nor the recognition of art education as the true source of industrial power less clear, in France than it is in England.

If the example of the latter country is worth more to us than that of the former, it is because her methods are more thorough; because her technical instruction is more truly artistic; because the art that is taught in all her schools, even the most elementary ones, is more unmistakably the true thing, and not a lifeless conventionalism that has come to be accepted as a substitute.

Now I think the greatest danger which attends this effort to extend industrial education here in America is that the supreme claims of art will be either neglected or recognized in mistaken or inadequate ways. It is certainly not on the side of mechanical ingenuity and skill that we are deficient, and it is not in promoting these that industrial education will be most efficient. The school aims, does it not, to supply the influences and the equipment that are not already "in the air" or available in the shop and the factory as they actually exist?

It is not, as I take it, so much with the intention of supplanting, as of supplementing, the experience of the shop that we are learning to intrust so large a par of the training of the apprentice to the organized methods of the school. To bring the shop, as it exists, into the school is not enough. The things which the school aims with most persistence to supply are precisely those from want of which the shop itself suffers the most.

These are, I am sure, scientific knowledge of materials and processes and artistic ability as the informing force of productive effort, and so my idea of industrial education, in whatever form or grade of school it becomes a feature, is emphasis and extension of scientific methods of investigation of these materials and processes, involving of course the story of their evolution, and the cultivation of the artistic sense in the midst of surroundings and by means of appliances that shall familiarize the pupil with the possibilities and the requirements of industrial forms of artistic expression. This means of course that good examples of industrial art in considerable variety should always be accessible, as well as good collections of casts, and good pictures should be continually before them. I think the importance of the unconscious influence exerted by the mere presence of beautiful things is still very imperfectly appreciated, and I cannot help feeling that it is virtually impossible to make much progress in cultivating the artistic sense of our children until we bring together either in the school room itself, or so near by that they shall really form part of the school appliances, good collections at least of casts, prints, and photographs of works of industrial merit.

A few good beginnings have been made in this way already, but they are only beginnings, and however admirable and even complete they may ever be made in themselves, they can never be regarded as anything more than beginnings, as far as the needs of the country at large are concerned.

The collections of casts which have already been formed at the Metropolitan Museum in New York, at the Boston Museum of Fine Arts, and better still, as far as sculpture alone is concerned, at the Slater Museum at Norwich, Connecticut, certainly form the most substantial contributions that have yet been made among us toward that education of the public taste on which, here in democratic America at least, everything depends.

I attach this great importance to casts from the masterpieces of sculpture as compared with forms of art for several reasons. In the first place they are the best possible substitutes for originals which the rest of the world must always go to Europe to see. Paintings cannot be copied in anything like as satisfactory a manner, and even if they could be, the expense would be out of all proportion to the importance of the work. In the second place, the sculpture is much the most important part of the legacy which the ages have left us.

The student of art who is intelligent and sympathetic finds infinite interest and inspiration in the old masters of painting, but he does not find *models of perfection*, in the sense that he finds them in Greek sculpture. When his admiration is profoundest in the case of the former, he makes reservations and allowances which have no place in his estimate of the latter.

This is not the place to discuss my reasons for this rather sweeping generalization, but I think the truth of my assertion will not be seriously disputed, and could be satisfactorily proved if it were worth while to argue the matter here. It is impossible, then, to overestimate the importance of efforts to bring together those casts which reproduce with absolute fidelity those works which stand for most as models of what art should be and mean. It is impossible to estimate the influence they exert on those who come in contact with them; not only on students of art, but on everybody else who sees them; first as object lessons in history, and second as unconscious, and therefore incalculable, influences in forming standards of excellence by which everything else in our experience is tried. It is this last that is the great thing after all.

The mere presence, then, of such works as these is education, and if proper efforts are made to point out and lead pupils to understand and appreciate their beauty to the fullest extent, their presence will stand for a very high kind of education indeed, and I wonder a little that while we see so much evidence of really earnest and generous purpose to assist and encourage the study of art, so many endowments of art schools and of offerings of prizes and traveling scholarships, I wonder a little that no one seems to have remembered how much good might be done by putting into the schoolrooms of the land (as far as possible into *every* schoolroom) something of the influence which these objects exert.

* A lecture delivered at Sibley College, Cornell University, May 3, 1891, by L. W. Miller, Principal of the Pennsylvania Museum and School of Industrial Art, Philadelphia.

At present, as you know, good plaster casts of interesting objects, suitable as models for study as well as for the purposes I have described, cannot even be bought in any great variety in America. What better work could be done than to provide facilities by which really good fresh casts from work of acknowledged merit could be furnished to schools, and suitably arranged, at a minimum of expense?

And this, indeed, is one of the things which we are trying to do in Philadelphia; that we do not do more is because our means are so limited. We have neither suitable buildings nor revenues large enough to conduct the work on the scale which it deserves. Meantime we do what we can and preach the crusade whenever we can get a hearing.

Again, I think it is important and almost inexcusable that none of our schemes for public buildings, on which we certainly spend money enough, include any recognition whatever of either painting or sculpture. In saying this I do not forget the acres of so-called ornament, the designing of which the artist is usually expected to "throw in" when he furnishes the plans for the building, and the execution of which is not expected to make any difference with the price of the contract, in which it is included, as if the contractor should agree to furnish so many cubic yards of brick or stone moulded or cut in shapes to suit, whether plain or ornamental does not much matter.

The most frightful example of this unfortunate state of things that exists in America, which is of course the same thing as saying "in the world," is the new city hall in Philadelphia, but something very much like it is to be seen almost everywhere where really ambitious architectural work is going on, or has been recently accomplished.

In domestic architecture we are doing very well. The picturesque constitutes, undoubtedly, about the lowest element of interest in artistic building, but it is truly and genuinely an artistic element, and its cultivation and appreciation, if not by any means the great thing which so many of our friends, the younger architects, seem to think, is sound and good as far as it goes.

In the modest forms of expression which this form of the picturesque assumes in adding grace to the city residence and charm to the country house, we have certainly done and are doing exquisite things, to which full credit is to be given always; but it is well within the truth to say that since the classic influence that gave a touch of dignity to public buildings everywhere and made Washington a really majestic city, since this has died out, anything like successful effort in imposing and monumental building has been exceptional and personal, while the tendency of prevalent taste has been depressingly degenerate and the multiplication of dead failures, the accumulation of architectural horrors, something awful to contemplate.

I do not forget, then, the really good work which we are doing in architectural design, nor those modest forms of ornament which we have undoubtedly learned to apply with good taste, nor do I forget that occasionally a group of allegorical figures, having considerable interest as sculpture, is perched upon the top of a post office or court house, two or three hundred feet above the pavement; nor the two good pictures which were once painted in the State house at Albany; but neither of these exceptions is of sufficient importance to impair my statement that in our public buildings we virtually ignore the claims and reject the service of painting and sculpture. What a confession of rudeness, of barbarous indifference to the things of the heart and mind does this neglect imply!

Æneas, wrecked on an unknown and undreamed-of shore, first took heart at the sight of the pictures of the Story of Troy, which grew as fast as the new buildings of Carthage furnished wall space to receive them. Surely, he said, we are among people whose hearts are kind, for see they have been touched by our story too.

What evidence of kind hearts and human interest would the shipwrecked sailor find on the walls of any building whose doors he would find open in any city on our Atlantic coast to-day?

Another way in which much good might be done would be found in purchasing meritorious works at the exhibitions. Our exhibitions contain every year works by American artists whose pictures are distinguished and honored in the best exhibitions of Europe, and yet, unless they are small enough to be comparatively insignificant and only fit to hang in the parlor or dining room of a city dwelling, nobody ever seems to think of such a thing as buying them for public places where they would delight thousands of hearts every year; why not have them in school houses where they would be at once a benediction and an inspiration; in the town hall or the court house; even in the post office if you please. They would add dignity and interest to public life; they would perpetuate memories of noble actions, and shed gentle and kindly influences on millions of hard and narrow lives. We are certainly wrong in this, that such art as we have is for the few, and not for the public places where all may enjoy it.

I have dwelt at such length on these indirect methods of art education, not only because I think they are quite as important as those which belong more distinctly to the schoolmaster's domain, but because it seems to me that success in administering these last is practically dependent on the influence of such conditions as I have indicated as desirable.

After all nothing is so necessary to art as an atmosphere, and no effort can be misspent that tends to promote that. Possibly this is what schoolmasters are for as much as anything else.

But to come back to the things which belong more directly and unmistakably to the teacher's province, what organization of school methods seems most likely to promote the aims and ends in which so much interest is felt at present? How shall these methods be made at once thorough on the side of art and science and practical in their bearing on industrial life? One idea seems mainly to dominate the discussion of this question here in America, and that, as it seems to me, a false one. It is this: that it is not desirable to teach particular trades or arts in the schools, but only elements and beginnings of all the trades, and so "technical high schools" and "manual training schools," institutes of one thing and another, are springing up all over the country, in which the aim is confessedly not to teach anything well, but only rudiments and smatterings of everything.

Now I hold that this is a mistake in the organization of special schools. Against the ordinary manual training school as part of the public school system I have nothing to say. Its scholars are still school children, and all the manual exercises that are introduced are, after all, clearly only adjuncts to the ordinary curriculum of the common school. Their value lies partly in the healthy alternation of manual with mental occupation; partly in supplying that contact with material things and natural forces of which the ordinary city boy or girl would otherwise know so little; partly in familiarizing the pupil with tools whose use will make him useful at home or apt as an apprentice, but mainly after all in the moral significance of the influences they exert. That they lead to and encourage high and just views regarding the dignity of labor, and inspire interest and ambition in connection with the occupations on which the comforts of life depend, thus tending to correct the false and foolish views which so much of the older teaching and so much vicious example in society itself tend to inculcate. This is the really great merit of the manual training idea which is coming to fill so worthy a place in the public school system of America.

It is not against this that I have a word of criticism to offer, but I do deplore the mistake which philanthropists and public-spirited people seem to me to be making in founding special schools to do substantially this same work which is going on, and ought to go on, and will be best accomplished in the public school.

People go, or ought to go, to the special school to learn to know, or to do, some special thing *well*, and this object will never be attained if they try to do everything else at the same time. The school which aims to promote industrial education in a really serious way should make up its mind what industries it will deal with and then stick to them and carry instruction in them as far as possible; set higher standards for them; lead people to see how much there is in them, how interesting and important they may be made; how much they stand for in human development; how much opportunity they offer for the exercise of intelligence, and taste and skill; how far and in what ways they link themselves to our highest faculties and enlist our highest powers in their service.

No; the trades should not be nebulous possibilities on the educational horizon; they should be centers of interest about which to gather your educational forces.

This is, I think, the lesson which we in America and our cousins in England alike have to learn from our neighbors in the Continent of Europe—the lesson of thoroughness. We have had far too much of the elements of this and the rudiments of that. Let us learn to do something well. It does not much matter what, so that we get to the bottom of it. It will be found to have been well chosen if we leave it well done.

Now, on the side which faces art, in matters where the taste and feeling of the artist are the surest, nay, the only safe guide, we are not doing well, and the reason is, as it seems to me, because we do not get close enough to the artistic spirit on the one hand and do not find or make the connection with industrial endeavor on the other.

We have a good many art schools and good work is done in them, there is no doubt about that, but they have only the remotest connection with industry, and the energy they develop finds its application in industry, if at all, by roundabout and wasteful ways, while the industrial schools, as I have tried to show, are dominated by a purpose which is not only not artistic, it is not even seriously industrial. I want to see the truth which Napoleon proclaimed, that all trades are arts if properly followed, recognized as it deserves. I want to see the artistic and the industrial not only associated, but inseparable; to see artistic aims everywhere anchored to industrial methods, and I think the way to secure this is to insist upon the closest possible connection in the school itself of artistic and technical training.

Allow me to explain a little in detail what I mean both by this artistic aim and this industrial association. A common mistake as it seems to me, in discussion regarding practical aims in teaching drawing, is made in confounding the practical with the mechanical. Teachers overestimate, I am afraid, the disciplinary value of the rigidly exact work which it is comparatively easy to get pupils to do by means of instruments.

To make drawings that are perfectly neat and perfectly distinct in every part; in which lines that are supposed to be straight are so in reality; in which every detail is correctly and clearly outlined and of exactly the proper size, in which the solidity of the forms is emphasized by shadows which fall without the slightest uncertainty, as they must if lighted in this particular although perfectly impossible way—all this is immensely attractive to a class of minds which exerts, and on the whole deserves to exert, a good deal of influence in educational affairs. But it seems to me that we ought to be exceedingly careful to impress upon everybody who cares for this subject at all, the fact that the working out, by means of mechanical appliances, of the series of problems which drawings of this kind present is really not drawing at all, and the most satisfactory accomplishment according to the standards just noted may not indicate the slightest development on the part of the pupil in the direction of grasping the essential things with which art has to do.

It is not merely that mechanical execution which depends for its accuracy upon the use of drawing instruments, T-squares, triangles, compasses, etc. It is not this alone, or even mainly, to which this caution is intended to apply. What is mainly to be dreaded and guarded against are the mechanical *habits* which the mind itself is apt to acquire and which are so often overestimated in the disciplinary work of the drawing school.

The pupil is often taught to think so much about the few things in a drawing that admit of measurement or demonstration that it is comparatively easy for him to miss more important qualities, and while mastering certain truths with much apparent firmness, to fail of attaining a real grasp of his subject, even the point of view of the true artist regarding it.

Accuracy alone, then, of whatever kind, is not enough. A drawing, even the most elementary, should contain some evidence of appreciation of the essential qualities of the object represented.

CHEMICAL RETTING.

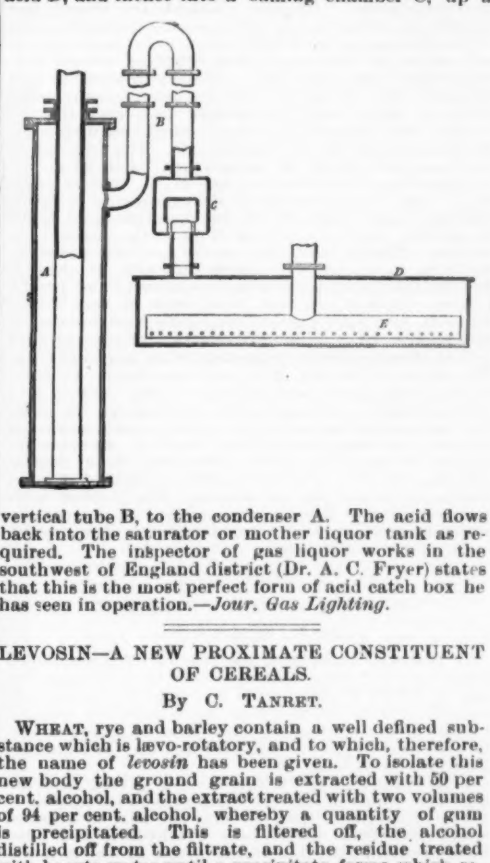
M. C. F. DE LA ROCHE has obtained a French patent for the following process of retting textile fibers: The material is first boiled for 1—2 hours in soap and water, then a solution of one-third the weight of soap used, of hydrochloride acid is added, whereupon the soap is decomposed into alkali, glycerine, and natural fatty acid. The latter being attracted by the fiber, dissolves and liberates the resinous matter, which rises to the surface of the lye. The glycerine dissolves the lime and metallic salts, and at the end of 2—3 hours the fiber is free from all fat and resin, but is impregnated with fatty acids. The latter being saponified by an immersion of 2 hours in a slightly caustic alkaline bath, the material is rinsed, passed into a bath of borax at ½° B., drained and dried.

To obtain and bleach vegetable textile fibers, Geo. J. Bruck proposes first to boil the ripe and dry stalks in soap water in order to dissolve the pectine and render the gummy matters gelatinous, which are then washed out in hot and cold water. The fiber is then laid down in a solution of permanganate of potash or soda to oxidize and destroy the remaining gums and colored matters, and again washed in cold water. Finally, the permanganate is removed by a bath of sulphuric acid and by washing in cold water; then follow bracking, swingling, and hackling as usual. It is claimed that the fibers are thus completely retted and bleached in much less time, and are longer, softer, and of much better quality than those obtained by other retting processes.

CATCH BOX FOR SULPHATE PLANT.

THE accompanying illustration shows the acid catch box for sulphate of ammonia plant, devised by Mr. C. Stafford Ellery, the engineer and manager of the Bath Gas Works.

The action of the appliance may be explained in a few words. The fumes from the saturator pass through a perforated lead pipe E in a tank of weak acid D, and thence into a baffling chamber C, up a



vertical tube B, to the condenser A. The acid flows back into the saturator or mother liquor tank as required. The inspector of gas liquor works in the southwest of England district (Dr. A. C. Fryer) states that this is the most perfect form of acid catch box he has seen in operation.—*Jour. Gas Lighting.*

LEVOSIN—A NEW PROXIMATE CONSTITUENT OF CEREALS.

By C. TANRET.

WHEAT, rye and barley contain a well defined substance which is lævo-rotatory, and to which, therefore, the name of *levosin* has been given. To isolate this new body the ground grain is extracted with 50 per cent. alcohol, and the extract treated with two volumes of 94 per cent. alcohol, whereby a quantity of gum is precipitated. This is filtered off, the alcohol distilled off from the filtrate, and the residue treated with baryta water until a precipitate forms, which redissolves at once. The solution is filtered and the filtrate boiled with a large excess of baryta water, when a precipitate is formed which is filtered, washed with baryta water and decomposed by carbon dioxide. The resulting solution, after filtering off the barium carbonate, contains the levosin, which remains behind on evaporation, still contaminated, however, with 0·5—1 per cent. of barium salt, which can be removed by dissolving the above residue in 60 per cent. alcohol, and separating the barium by addition of the requisite quantity of sulphuric acid. The barium sulphate is then filtered off, the levosin precipitated by the addition of 95 per cent. alcohol, taken up with water and the aqueous solution evaporated. Levosin is a white amorphous solid, soluble in water in all proportions, very soluble in dilute, but almost insoluble in strong alcohol. It melts together at 145° C., but is only completely melted toward 160° C. Its specific gravity is 1·62, and its rotatory power, which is unaffected by temperature, $[\alpha]_D = -36°$. An analysis of the product dried at 110° C. points to the empirical formula $C_{12}H_{20}O_{10}$; a molecular weight determination by Raoult's method to the molecular formula $C_{48}H_{80}O_{40}$. Exposed to the air the dry substance takes up 4 molecules of water to form the hydrate $C_{48}H_{80}O_{40}.4\,H_2O$. Levosin does not reduce Fehling's solution, nor does it undergo fermentation either with yeast or with diastase. The hydrate is very readily hydrolyzed by dilute acids, and even by heating with water to 100° in a sealed tube for 24 hours. The resulting solution has a rotatory power $[\alpha]_D = -76°$, and contains about 75 per cent. of levulose, the remainder being a feebly dextrorotatory glucose.

Levosin is not attacked by solutions of the alkaline hydrates; it forms compounds with bases, some of which have been analyzed. The barium compound,

$C_{48}H_{86}Ba_4O_{40}$, is formed by the addition of baryta water to a solution of levosin. It is insoluble in an excess of baryta water, and is dissociated by water into the compound $C_{48}H_{88}Ba_2O_{40}$, which is only slightly soluble. In presence of sugars, however, this barium salt redissolves, until the former are completely saturated, a fact which is made use of in the method given for the isolation of levosin. A calcium salt, $C_{48}H_{88}Ca_2O_{40}$, and two lead salts $C_{48}H_{86}Pb_4O_{40}$ and $C_{48}H_{84}Pb_6O_{40}$ are described. Lead acetate precipitates the former of these lead salts only after addition of alcohol; the latter is insoluble in water and results when levosin is treated with an ammoniacal solution of lead acetate.

Levosin yields both a tri-acetyl and a tetra-acetyl compound. With nitric acid a slightly explosive ester results in the cold. On further action oxalic acid is formed without the intermediate production of mucic acid.

Levosin has been found in rye, wheat, and barley to an extent varying from 0·3 to 2·0 per cent. on the dry material. Barley contains the most, and the quantity is greatest when the cereal is matured. When dried, wheat and barley only contain 0·1—0·2 per cent. of levosin. None was detected either in oats or in dried maize.—*C. A. K., Compt. Rend.*

A NEW ALKALOID FROM JAVA COCA LEAVES.

DR. F. GIESEL communicates a note to the *Pharmaceutische Zeitung*, in which he mentions that the narrow-leaved Java coca contains up to 2 per cent. of alkaloids, but only very little cocaine. The principal alkaloids are cinnamyl compounds, besides crystallizable cinnamyl-cocaine, as well as truxilline. From 20 kilogrammes of the alkaloids he, by fractionation, obtained 1 kilogramme of cinnamyl-cocaine, and from the mother-liquor containing the amorphous cinnamyl compounds he has been able to isolate, as a hydrobromide, an alkaloid bearing a great resemblance to the dextro-cocaine which Einhorn prepared from dextro-ecgonine. Of this alkaloid Dr. Giesel has secured 80 grammes. It possesses the characteristics of cocaine and nearly allied bodies, so far as physiological action on the tongue and behavior toward permanganate are concerned. The hydrobromide and nitrate of the alkaloid showed the same sparing solubility in water as dextro-cocaine does, and, like it, the free base separates as an oil, which, on dissolving in ether, can be obtained in crystals. The alkaloid so obtained melts at 49° C., as compared with 46-47° C., the figure for dextro-cocaine, and 97° C., that of cocaine. The hydrochloride of dextro-cocaine is fairly difficult to dissolve in water, but dissolves more easily in alcohol, and crystallizes from both solvents in needles. The hydrochloride of the new base dissolves easily in water, but with more difficulty in alcohol, and crystallizes from the solutions in small and pretty prisms. Salts of the new body, even in very dilute solution, give a crystalline precipitate with potassium bichromate, whereas similar solutions of cocaine and dextro-cocaine remain clear, or give an oily turbidity. The alkaloid does not affect polarized light. Concentrated hydrochloric acid splits it up into benzoic acid and ecgonine, in the calculated proportions for cocaine, without giving, as in the case of dextro-cocaine, a difficultly soluble intermediate product. In other respects the alkaloid shows differences from dextro-cocaine, and Dr. Giesel's conclusion is that it is an isomer or homologue of cocaine. The author adds some criticism of Hesse's recent work on hygrine, in which he maintains the natural existence of that body. —*Chemist and Druggist.*

COPPER IN OIL OF LEMON.

By W. H. MCGRATH.

IT is a well recognized fact that oil of lemon which has remained for any length of time in the copper vessels in which it is imported is liable to become contaminated with this metal, owing to imperfect tinning; but, although occasionally attention has been drawn to this impurity, I do not recollect any method proposed for its elimination.

I have much pleasure, therefore, in giving in detail a process which in my hands has proved successful.

The oil operated upon (6 liters) was part of a parcel which had been accidentally overlooked, and must have been some months in the drum in which it was found. On examination it had all the appearance of oil of bergamot, and being tested gave a distinct copper reaction.

To get rid of the metal without injury to the oil was now the object. Keeping this end in view, I proceeded as follows:

A dilute acid was made consisting of 1 part of sulphuric acid and 2 parts of water. Several experiments were tried with small quantities of oil in order to ascertain how much of this dilute acid would be necessary, not only to absorb the copper, but to obtain this result in the most expeditious manner, the quantity finally determined being 1 c. c. dilute acid to 28 c. c. of the oil, or about 15 minims per oz.

In this proportion the bulk was now treated with dilute sulphuric acid, and shaken together until the green color of the oil disappeared, which was in the course of a few minutes; about 1 liter of water was added, again well shaken, and allowed to stand until separation took place, which was in a quarter of an hour. The acid solution was siphoned off, and put on one side for estimation of copper. The oil was now repeatedly washed with water until perfectly free from acidity, the water siphoned off, and the oil digested with dried sodium sulphate for twelve hours, and filtered through double paper filter. The result was unquestionably good, and, to my mind, the oil appears to be somewhat improved by the treatment. The acid solution which now contained the copper was estimated by the color titration process, and gave 0·00525 per cent.

As a comparative experiment (in order to see whether dilute sulphuric acid exerted any influence other than that of separating the copper) a sample of the very best oil of lemon was procured from a source which could leave no doubt as to its purity, and this was subjected to precisely the same treatment, with virtually no effect whatever upon the oil.

QUINETHYLINE is the name which Grimeaux & Arnaud have given to a base (homologous to quinine) which they have prepared from cupreine. It may be regarded as the second of the group of synthetic bodies of which quino-methyline, the isomer of quinine, was the first. In their communication on the new base to the Paris Academy of Sciences, they state that, to make it, the sodium compound of cupreine is taken and treated with chloride or bromide of ethyl, or, preferably, with nitrate of ethyl, and the whole is heated in a sealed tube at 95° to 100° C., the reaction being complete in from 2 to 5 hours. The contents of the tube are then treated for the separation of unaltered cupreine, the new base being dissolved out with ether. In the free state it is a white amorphous substance like quinine, melts at 160° C., and is soluble in ether, alcohol, chloroform, and other alkaloidal solvents. The solution in excess of sulphuric acid is fluorescent. In other respects it resembles quinine, yielding crystallizable salts, including a hydrate, and a neutral and basic sulphate, and is levogyre toward polarized light. It is to be hoped that the physiological and therapeutic effects of this interesting body will be studied.

PETROLEUM GAS.

THE Chicago *Journal of Commerce* states that a new process for the manufacture of gas from petroleum has been put into practice at Kittanning, Penn., by which it is claimed gas can be manufactured at one-half the cost of the old, and is much better for illuminating purposes. The method is a very simple one, consisting of a feeder and a system of retorts. These retorts are kept at a certain heat, and the oil forced through them into a receiving tank filled with water. When the heated oil strikes the water it turns into gas, and is conveyed from there to the supply tank, ready for use. It is said that four thousand feet of gas can be manufactured from one barrel of Lima oil.

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